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The Official Agreement of the Arbitration Board.

The following is the full text of the resolutions unanimously adopted by the Arbitration Board of the National Metal Trades Association and the International Association of Machinists recently held in this city:

WHEREAS, Conflict between capital and labor has been disastrous alike to each, the International Association of Machinists and the National Metal Trades' Association, appreciating the importance of adopting some measure that would provide against strikes and lockouts in the future, met in joint conference for the purpose of adopting such measures as would be alike just to the employee and the employer. This conference meeting in New York, May 10, was in continuous session until May 16, having formulated a code by a series of resolutions, which for the first time established the value of national arbitration, and by their act has, it is believed, made history which will benefit all other like organizations.

Resolved, That the strikes be declared off in the factories of the members of the National Metal Trades' Association in the cities of Cleveland and Paterson, the National Metal Trades' Association members of this board to wire the members of their association in these two cities to meet a committee from each shop of their former employees to arrange for the return of as many men as their present necessities require; and that subsequent requirements of men shall be filled from their former employees whom they may not be able to reinstate at the present time.

The intent of this last clause is that if, within the next six months, former employees make application for reinstatement they shall be reinstated, provided there are vacancies for them.

Where strikes exist in these cities in firms other than the members of the National Metal Trades' Association who will agree to the settlement herein entered into, after the same has been adjusted by this joint body, such strikes shall be declared off, also.

WHEREAS, Doubts have been expressed by members of this board, representing both parties to this conference, as to the ability of their respective organizations to control their members; now, therefore be it

Resolved, That the members of this board pledge themselves, each to the other, that in case of the refusal of any member of the respective organizations represented to observe and carry out in an honorable manner the findings and decisions of this board, in regard to strikes and lockouts, based upon a fair, just and liberal interpretation as to what is known as the Chicago agreement, we will report such member or members to our respective organizations for discipline, suspension or expulsion, as the merits of the case may justify.

MACHINIST.

A machinist is classified as a competent general workman, competent floor hand, competent lathe hand, competent vise hand, competent planer hand, competent shaper hand, competent milling machine hand, competent slotting machine hand, competent die sinker, competent boring mill hand, competent tool maker and competent linotype hand.

To be considered a competent hand in either class he shall be able to take any piece of work pertaining to his class, with the drawings or blueprints, and prosecute the work to successful completion within a reasonable time. He shall also have served a regular apprenticeship or have worked at the trade four years.

It is understood that the question of competency is to be determined by the employers. Since the employers are responsible for the work turned out by their workmen, they shall, therefore, have full discretion to designate the men they consider competent to perform the work and to determine the conditions under which it shall be prosecuted.

This last paragraph does not in any way abridge or destroy the right of appeal from any apparent or alleged unjust decision rendered by an employer of labor or his representative in conformity with the powers vested in him by this paragraph.

OVERTIME.

All overtime up to 10 o'clock P. M. shall be paid for at a rate not less than time and one-quarter time, and all overtime from 10 P. M. until 12 midnight shall be paid for at a rate of time and one-half time, and that after 12 o'clock and legal holidays and Sundays shall be paid for at a rate of not less than double time.

In cases of emergencies, where shop machinery breaks or runs down, and it is absolutely necessary to repair the same so that the factory can run on Monday, this shall be paid for at a rate of time and one-half time. The repairs above referred to apply only to the machinery of the employer.

The foregoing rates not to interfere in any way with existing conditions; that is, where a higher rate than the above is paid now no reduction will take place.

Such rates for overtime shall not apply to men regularly employed on night gangs.

APPRENTICES.

There may be one apprentice for the shop, and in addition not more than one apprentice to every five machinists. It is understood that in shops where the ratio is more than the above that no change shall take place until the ratio has reduced itself to the proper number by lapse or by the expiration of existing contracts.

HOURS.

Fifty-seven hours shall constitute a week's work from and after six months from the date of the final adoption of a joint agreement, and fifty-four hours shall

constitute a week's work from and after twelve months from the date of the final adoption of a joint agreement. The hours to be divided as will best suit the convenience of the employer.

NOTE.—This not to interfere in any way with shops where a less number of hours per week is already in operation.

Spain's Machinery Trade.

In spite of the wars and consequent general excitement and heavy taxation, the trade and native industries in Spain have not suffered as greatly as was expected. The loss of the colonial markets, on which the export trade of Spain greatly depended, has made it necessary for the government to take serious steps towards finding new markets and stimulating and enlarging those already known.

The imports into Spain largely increased in 1899. Taking the whole import trade of Spain, we find that it amounted to 936,536,384 pesetas in 1899 as compared with 603,128,087 pesetas in 1898, an increase of about $66,000,000. (The peseta is of the same value as the franc of France, 19.3 cents, and for convenience may be called one-fifth of a dollar.) An immense increase especially took place in the importation of machinery, carriages and vessels, which rose from 37,444,109 pesetas in 1898 to 101,930,639 pesetas in 1899. This amount is composed of the following principal items:

	Pesetas.
Ships of iron and steel.....	59,260,800
Agricultural machinery.....	443,425
Power machinery and boilers..	5,764,394
Locomotives and portable engines	614,463
Machinery made of copper (especially sugar machinery).	577,896
Sewing and knitting machines.	2,679,236
Other industrial machinery....	30,855,717
Carriages and cars.....	1,300,000

It will be seen from these figures that a great number of these imports consisted of iron vessels which were bought in foreign countries for the Spanish Merchant Marine and for the Navy. The amount expended upon these purchases is given as 59,260,800 pesetas in 1899, as against 9,778,000 pesetas in 1898 and 16,623,679 pesetas in 1897.

Unfortunately, detailed statistics on the importation of the different kinds of industrial machinery for 1899 are not yet available. The imports of agricultural machines and implements increased from 167,263 pesetas in 1898 to 443,425 pesetas in 1899. Up to the present time agricultural machines and implements used in Spain have been imported chiefly from Great Britain, France and Germany. Our exports in agricultural machinery and implements to Spain, during the fiscal year 1899, were: Plows and cultivators, $1,245; all other agricultural machinery, $801.

By proper and systematic efforts we should be able to largely increase our trade in this line. Spain is largely an agricultural country, but the use of modern implements and machines has been very limited so far.

Machine tools also are imported, chiefly from Great Britain and Germany. First-class tools come principally from England, and only to a small extent from the United States. Low-class tools come from the continent or are supplied by local makers, who try to copy English models as to design, but leave much to be desired as to finish and accuracy of workmanship.

During the last fiscal year we sent only $8,950 worth of machine tools in direct shipments to Spain, though it is estimated that the total imports of machine tools amounted in 1899 to a value of, at least, $150,000. It is a well-known fact that the machinery industry of Spain is still in its infancy, and of greater workshops, there are only a few in Barcelona and its districts. According to a census recently taken in Spain, the following number of machines were then in use in the country:

(a) In large industries: 10,022 machines, with a capacity of 100,070 horse-power.

(b) In the mining industry: 796 machines, with 20,136 horse-power.

(c) In small industries: 2,160 gas motors, with 7,500 horse-power; 86 steam engines, with 140 horse-power.

At the same time there were 1,466 railway locomotives, with 455,277 horse-power, and 3,300 hydraulic motors, with 75,401 horse-power.

Mining machinery is chiefly imported from Great Britain. Spain is rich in all kinds of minerals; but most of these industries are not developed as they could be, with the possible exception of the iron industries.

Large is the demand for textile machinery, and especially for cotton spinning and weaving machinery. This branch of machinery trade remains almost exclusively in the hands of the British makers. During the past few years German and Swiss-made cotton machinery has also made its appearance in the Barcelona districts, but no American machinery has ever been sold there.

A great field is open in Spain to electrical enterprises. The country is rich in powerful rivers and waterfalls, and electricity has made great progress during the last few years. Considerable quantities of electrical machinery are now imported from Great Britain, Switzerland, Germany and France. It is estimated that in 1899 the imports of all kinds of electrical machinery amounted in value to at least $500,000, of which very little came from the United States. Our total exports of electrical machinery to Spain amounted in value during the last fiscal year ending June 30, 1899, to only $3,326. Hundreds of electrical enterprises are now under construction or are contemplated; in many cities the horse-cars are being converted into those of electric traction, and electric lighting plants are constantly being installed all over Spain. In this line, too, American manufacturers should be able to secure a large share of the increasing trade. The sugar industry also is making tremendous progress in Spain.

It would lead too far to enumerate all the many kinds of machines which would find a ready sale in Spain if properly brought to the knowledge of the Spanish buyer. We have already mentioned that up to the present time our share in the machinery trade of Spain is very unimportant, and we must not expect to get orders from Spain by simply throwing English catalogs upon that market. The Spaniard, as a rule, is a good business man, and he places his orders where he gets the best goods at the cheapest prices. If we can offer him either a better machine than that which he now buys from England or from Germany, or if we can sell him the same machine at a cheaper rate, we will doubtless get the order. Unfortunately, foreign languages are our weakest points, but we shall never get at the trade of any country if we do not correspond in the language of the country. Before concluding our remarks, we should like to call the attention of American manufacturers to the great imports of Spain in the following articles: Files, rasps, saws, hammers, tongs, chisels—in one word, all small hand tools used by carpenters, blacksmiths, tinsmiths, plumbers, carriage builders, etc. A large demand exists also for coopers' tools, especially in the southern part of Spain, where the great wine-producing centers are situated.

H. L. G.

A Steam Engine to Come.

A writer in the "Threshermen's Review" ought to come to New York and organize a company and sell stock before the liquid air sharps gobble the market. Hear what he says "in conclusion:"

"I want to say in conclusion that the steam engine of to-day will soon be piled in the back yard for old iron, for I have invented a steam engine that is propelled without the aid of a steam boiler. It is a real steam engine of the modern size, not a vest pocket engine like Grant Bramble's, or the so-called engine, but a real steam engine that generates its own steam without the aid of a boiler. I would like for some of the brother threshermen to write on this subject and tell how he thinks such an engine could be made. I will give you all plenty of time to write on this subject, and some time during the coming season I will fully explain this engine through the pages of 'The Threshermen's Review.' Let all eyes watch 'The Review' for this remarkable engine."

Serious trouble seems to be in store for us in the near future on account of the rapid rusting of steel nails. Both wire and cut nails of steel rust much more rapidly than iron.

Commercial Review.

NEW YORK, Saturday, May 26.

MACHINE TOOL MATTERS.

Unquestionably there are weak spots in the prices of machine tools. It is alleged that certain dealers, heavily stocked, are making concessions, and what is more, that some of the Western manufacturers are offering tools at figures which contrast sharply with those of the large and prominent companies whose quotations maintain their integrity. That the market is generally inclined to fall we do not say, but there are adventurers in the field anxious to get business at any price. It may easily be that where great advances were made last year they will be pruned off a little as trade settles to the healthful normal basis on which it bids fair to stand in the future. But since those advances were not on the average excessive, and in some cases were trifling, it is difficult to see where there is any room or occasion for a general drop, unless conditions are equivalent to a panic, which they are far removed from being. The machine tool output of to-day is a heavy one, there is no denying, and it will not be marketed without some difficulty, but its increase has not, perhaps, been far out of proportion to the growth of the country's tool using industries.

The demand for machine tools is good still, but verging toward quietness.

Beaman & Smith, Providence, R. I., are building an extension to their works.

EXPORT FACTS AND OPINIONS.

Ever since the early stages of the European export movement in machine tools it has been predicted that sooner or later our trade will feel the effects of the imitation of American tools in Germany. The time has come when such effects are felt very plainly. A prominent authority in this department of export trade tells us that of late the German market has become appreciably less lucrative because of the increased competition. There may perhaps be as much business in the aggregate, but there are more people after it, particularly native manufactuers who have copied American machines. The German market is still fairly good, he says, however, and may be regarded as satisfactory if it continues as it is at present. The demand in some of the neighboring countries is said to be excellent; in Austria, for instance, as remarked by an Eastern tool manufacturer who has returned from abroad.

The authority first quoted is not of opinion that a reduction in prices would cause a material increase in continental buying. As a matter of fact, there are many American tool builders on whose product there has been no radical advance.

One of the Eastern machine tool manufacturers has obtained a large contract for machine tools from the French Government. It was secured through the Paris agent of the firm.

A favorable indication of the foreign market is found in a report which has come from Europe that one of the largest firms on the Continent handling American tools, and whose trade embraces many countries, enjoyed in April a business which had been excelled in no previous month.

Berlin papers say that armor plate works will be established by the co-operation of several shipbuilding concerns at Rendsburg, Prussia, on Audorfer See. Among other new enterprises are a factory for plows and other agricultural implements, of Herr Even, at Norden, Hannover; a machine shop for manufacturing and repairs of A. Lamp, in Schönsee, Westpr.; the "Schiffsbauwerft Lucas," a shipyard in Cüstrin, in Brandenburg, Prussia, for building iron vessels. Georg Wächter, of Neukenroth, Bavaria, manufacturer of agricultural machinery, was contemplating extension of his work. There have been fires in the following establishments: Karlswerkes repair shop of Felten & Guilleaume at Mülheim am Rhein, Prussia, where the damage was over $100,000; machine shop of the "Briketfabrik der Kaiser-Wilhelmgrube," at Lichtenau, Germany, which was partly destroyed; the shovel and spade factory of C. Schroeder, at Hesseln, Halver i. W., with a loss of buildings, machinery, etc.

DYNAMOS AND MOTORS.

Manufacturers of electrical machinery have still enough orders in their shops to occupy their entire facilities, but in booking new work there is not the rush that there has been. The larger companies seem to be taking on all the new work they want, but some of lesser magnitude are not so complacent over the situation, and there is a tendency in certain quarters to make low bids in order to get work. This has been perceptible for the last sixty days, but especially within the last thirty. When prices were advanced to their present high basis, it may be remembered, the increased cost of material was offered in excuse as an imperative reason. The present conditions of the iron, steel and copper markets indicate that electrical manufacturers might afford to make some concessions before long. Whether they will do so naturally depends in great part upon whether they can get enough work at maximum rates to keep them employed otherwise. Most of them seem to have enough at present and would not acknowledge to cutting prices. It is a man's competitors who do that sort of thing—not he himself. These reported monetary leaks are almost as hard to locate as leaks in an air tank. It is but just to say that they are the exception rather than the rule.

In local electrical circles the installation of isolated plants in office buildings is always one of the chief topics of attention. New York has few machine shops of any size, but her independent lighting plants are something perhaps unequaled anywhere else in the world. For the last year building has been held up on account of the higher cost of materials to such an extent that, as we understand it, the building contracts or plans filed in New York, exclusive of Brooklyn and the other annexed districts, have amounted to about $20,000,000 less for the last six months than for the six months a year earlier. This, of course, includes structures both large and small. As to what extent the work that has been kept back in this way is beginning to trickle out now that prices of material are softening the reports we have heard do not agree. One electrical man regards everything as at a standstill. Another finds isolated plant work in a condition for more estimates than ever before, but this is a comparatively small feature of the building trades. Electrical workers have been on strike here for several weeks, but it is asserted on behalf of the contractors that they can get plenty of men, and are not embarrassed by the strike.

To judge from casual observation, there are prospects for some particularly fine office building plants here in the future. During a walk through the financial district of the city yesterday were observed within a few hundred yards of each other four sites on which the old groups of buildings, covering very extensive areas, are being demolished to make room for something more up to date. One is on the corner of Broad street and Exchange place, another on Wall and William streets, a third on William and Liberty, a fourth on Liberty, just back of the Mutual Life Building, intended, we believe, as the site of an annex thereto. Within a block or two from the last there were three smaller structures undergoing demolition or rebuilding, where isolated plants may or may not be placed. Some plants will also have to be installed in this city for the Government. The new Custom House, for which excavations are being made, will require a plant of several hundred kilowatts, but it will be a long time before the building is ready for it.

For the plant of the new immigrant station on Ellis Island bids have already been put in. There are to be two 100 and three 75 kilowatt machines, with engines direct-connected. The bids, which were opened May 22, were as follows: Ridgway Dynamo and Engine Company, Ridgway, Pa., $19,390. Thresher Electric Company, Dayton, Ohio, $28,838 for vertical engines and $28,138 for horizontal engines. The United Engineering Company, New York city, $23,734. Westinghouse, Church, Kerr & Co., New York city, $28,673.

An interesting electrical equipment for distributing power to individual machines is now being placed by the Bullock Electric Manufacturing Company in the Fall River Engine Company's new shipbuilding plant at Weymouth, Mass. The generator for the plant is a 100-kilowatt machine. About forty motors have been purchased

for the first instalment, and about as many more will be required hereafter. Among the makers of the machine tools which these motors will drive were the Niles Tool Works Company, Bement, Miles & Co. and the Fitchburg Machine Tool Company.

One of the electrical companies represented in town has lately been figuring on quite a number of contracts for direct-current generators in the neighborhood of 800 kilowatts for railway and central station lighting work. Some of this work is Canadian.

The Southampton (England) Borough Council and the Harbor Board are considering the purchase of a motor transformer to reduce part of the current from the town tramway system from 500 to 220 volts for use in operating the cranes on the quay. They are now run by a separate engine, which wastes a great deal of power, owing to the variableness of the load. The estimated cost of the new plant is $3,900.

The contracts for the steel work of the new works of the British Thompson-Houston Company and of the British Westinghouse Electric and Manufacturing Company were given to the same English firm—Dorman, Long & Co., Limited, of Middlesborough. There will be about 2,000 tons of steel in the former and 10,000 in the latter, the area of whose floors is about twenty-two acres.

CHICAGO MACHINERY MARKET.

The Chicago electrical machinery trade finds little encouragement in the present state of business in this city. There being no building operations, perforce the installation of electrical machinery and power is almost similarly non-existent. And the obstacles that are thus in the way of activity are augmented by the aggressive efforts of a large electrical company to induce owners of new buildings to buy current from wires instead of erecting individual equipments. But when the electrical machinery representative goes beyond the limits of the city he finds a rich field for the exercise of his commercial talents. He finds friends in abundance and he makes pleasing sales. Inquiries are quite numerous for electrical power, and it is observed that plants which have begun the instalation of electricity not uncommonly keep adding to it, both by way of encroachment upon former systems of power and by way of application to additional buildings. Prices show little change, large producers generally holding to old quotations, with the usual amount of shading by those anxious for contracts.

Armour & Co., who recently installed a large central plant in this city, have just bought additional motors, aggregating about 600 horse-power, for extended service in the same plant. The Anglo-American Provision Company is about to install several hundred horse-power in both generators and motors in the same locality. Printing offices continue among the readiest buyers of electrical equipment. The Dallas (Texas) "News" is about to put in an electrical plant for the entire operation of its establishment. The Baker-Vawter Company, which recently equipped one of its printing offices at Holyoke, Mass., with an electrical outfit, has just arranged to operate throughout with electricity a new plant which it is erecting at Atchison, Kan.

Among Western manufacturing plants also there have recently been a number of installations, with many others now under consideration. F. E. Myers & Bro., of Ashland, Ohio, have purchased from the Sprague Electric Company a generator of about 150 horse-power and motors aggregating 250 horse-power, with which their pump manufactory will be operated. The Geuder & Paeschke Manufacturing Company, Milwaukee, Wis., tinware, is installing a generator of about 250 horse-power, and will operate its entire plant, it is said, with motors. The Toledo Bridge Company, Toledo, Ohio, will shortly equip its plant with generator and motors of several hundred horse-power. Russell & Co., Massillon, Ohio, are providing generator and motors of about 250 horse-power for an addition to their works now under way. The American Luxfer Prism Company, Chicago, is installing about fifteen motors. Monroe Seiberling is asking bids for the equipment of his new glass plant at Ottawa, Ill., with electricity. About 2,000 horse-power will be required.

BALTIMORE NOTES.

Detrick & Harvey Machine Company reports a shop full of work and orders on its books for many months to come. Its open-side planers are being shipped to Europe and elsewhere, while a steady demand is manifested for its universal drilling and boring machines. The carriages for the 5-inch guns are almost completed, and will be turned over to Uncle Sam shortly. The bolt-cutting machine department is very busy, and is now so organized as to be in a position to cope with almost any demand that may be put upon it.

Ottmar Mergenthaler Company states that business in its adjustable reamers and flue cutters is excellent. The shop is full of work and running overtime. The outlook is taken to be of the most encouraging.

WILMINGTON NOTES.

Not less than twenty-five semi-automatic turret lathes are coming through the shop of the Automatic Turret Lathe Company, all ordered, both for this country and abroad. The day our representative was there three were on the cars bound for widely separated parts of the world. This company expresses itself as very well satisfied with the showing thus far, and has great confidence in the future. The lathes have already penetrated into the most conservative shops, and are said to be bringing about a remarkable change in working methods.

The output of the Hilles & Jones Company shows no diminution in quantity. Every department is working to its limit, and the orders on the books are increasing steadily. If any sag in the machinery demand has been noted, it has not yet made itself felt in this shop. It is not neglecting the foreign field, as, unfortunately, other manufacturers show signs of doing, but is giving it the fullest attention, as a possible sheet anchor to windward should times change.

Betts Machine Company, which has added considerably to its facilities during the spring, still finds them inadequate to its growing needs. It has increased the size of the foundry, and is about to introduce electricity to the cranes to expedite the work. This company did a most excellent business last year, and states that its tools are being called for from all parts of the world. It is fostering the foreign field and steadily increasing its business in that direction.

A. L. Henderer's Sons continue to make large shipments of their jacks and tube expanders. The orders have shown no falling off, and the shop is still behind, although facilities have been somewhat increased. They are looking forward to steady business for some time to come.

Quotations.

NEW YORK, MONDAY MORNING,
May 28, 1900.

Iron—American Pig, tidewater delivery:—

Pennsylvania Irons:

No. 1 X foundry	$21 00 @ $21 50
No. 2 X foundry	20 00 @ 20 50
No. 2 plain	18 25 @ 18 75

Alabama Irons:

No. 1 foundry	22 00 @ 22 25
No. 2 foundry	21 00 @ 21 25
No. 3 foundry	20 00 @ 20 25
No. 1 soft	22 00 @ 22 25
No. 2 soft	21 00 @ 21 25
Foundry forge	19 25 @ 19 50

Bar Iron — Base sizes — Mill prices on dock are 1.80 @ 2c. for good refined brands; store prices, 2.30 @ 2.40c.

Tool Steel—Base sizes—Standard quality, 6½ @ 8c.; extra grades, 12 @ 14c.; special grades, 16c. and upward.

Machinery Steel — Base sizes — From store, 2.45c., upward.

Cold Rolled Steel Shafting—Base sizes —From store, 3¾ @ 4c.

Copper—In carloads—Lake Superior ingot, 16½ @ 16¾c.; electrolytic, 16¼ @ 16⅜c.; casting, 16⅛ @ 16⅜c.

Pig Tin—In 5 and 10-ton lots, 29¼c., f. o. b., New York.

Pig Lead—¼c. in wholesale lots, carloads .02½ @ .05 extra.

Spelter—Prime Western, 4.50 @ 4.60c., New York delivery.

Antimony — Cookson's, 10¾ @ 11c.; Hallett's, 9⅝c.; United States, 9½ @ 9⅝c.; Japanese and Hungarian, 9⅜c.

The Paris Exposition—III.

EDITORIAL CORRESPONDENCE.

WORKMEN AND THEIR WAYS.

It is probable that some of the American machine builders who are here trying to push things toward the completion of their exhibits are getting a wrong idea of the French workman by not making sufficient allowance for the obvious fact that the best of them are, of course, regularly employed elsewhere, and cannot be picked up for temporary employment such as is offered them at the exposition. But, however that may be, to say that the aforesaid American machinery builders are a thoroughly disgusted lot is to state the case mildly, and when they get home it is to be hoped that some of them, at least, will have a considerably higher appreciation of American workmen and the important part they play in our foreign machinery trade. We are told that there is very little—almost no drunkenness in France; but when one finds an American machinery exhibitor sitting disconsolately or working savagely in the middle of his space, surrounded by parts of machines, packing cases and debris, deserted entirely by the men employed to help him, who are palpably and unanimously under the influence of common, plebeian beer, he changes his mind about this. Smoking pipes and cigarettes is a leading occupation among these men, and they roll their own cigarettes, very deliberately, while their pipes must often be refilled, and still more often relighted. One man noticed that among the gang working for him was one pipe smoker. They were lifting parts of machines and doing work that required correlated, or, so to speak, synchronous efforts. This pipe smoker always smoked, and seemed always stopping to relight, his stopping bringing surcease as well to all the others, who watched the operation and discussed things. The American exhibitor knew he was not in America, and stood this thing as patiently and as long as he could, but finally told the pipe smoker that he didn't so much object to his smoking, but he did most ardently wish that the blessed pipe could be kept lighted and so not cause so many intervals of repose. He further remarked that he was far from home, very sorry for it, and anxious if possible to get his exhibit in shape before his time came to die. Said he: "Do you think you could hold a job in a shop in America doing as you are doing here?" "Well," the fellow said, "if I could not smoke I would throw up the job." He probably would not throw it up, however, for reasons which every American shopman will readily divine.

SLOW PROGRESS.

The date for the final and entire completion of the exhibition is put farther and farther into the future by those who give attention to the matter, and an American engineer, whose position here has given him exceptional opportunities for knowing the inside doings, says that the administration of the exhibition is in a pitiful state of chaotic confusion and bewilderment—seemingly utterly unable to cope with the situation. Of course, it is difficult for an outsider to judge, but it is at least equally difficult to see why they should have been within the past two weeks digging up the ground within the machinery space at the Champ de Mars to lay water mains—work which we all know should be and usually is done at the beginning of such building operations. It seems somewhat encouraging, however, for one's nostrils to be greeted by the peculiar odor of newly heated steam pipes, as was the case a few days ago, and it is not unlikely that some boilers may be regularly under steam before long; and after that it cannot be much longer before at least some machinery will be in motion.

ACCIDENTS.

Our readers have, of course, heard of the fatal collapse of a footbridge here on April 29, but they have not heard of the many other fatalities which have been attending, and still attend, the carrying on of the work. The list is an appalling one, there being in one day sixty hospital cases, a large proportion of which were fatal. The papers here give little attention to them, we being informed simply, for instance, that "two painters fell from the Tour Eiffel yesterday and were killed." no names being given nor any further particulars. Only common workmen, you see. There is a great lack of proper appliances for handling heavy work, and it is a frequent occurrence for heavy pieces of machinery to fall and kill or maim a number of workmen. I believe the machinery installation at Vincennes has not been attended with any serious accidents, however, but one wonders what would have happened had the French workmen undertaken to put up a steel-framed building as rapidly as those of the Berlin Iron Bridge Company erected the machinery building at Vincennes.

ASSIGNMENT OF SPACE FOR MACHINERY.

Although every American exhibitor of machinery here whom I have met speaks well of Mr. Drake, the director of that department, there are things connected with the apportionment of space which some of them do not understand, and the feeling is quite general that there is somewhere something queer about it. So far as possible I have looked into the matter, and my conclusion is that Messrs. Drake and Peck have done all that could have been done under the circumstances. In the first place, as I mentioned previously, our governmental authorities took no action whatever until long after they should have done so; the space occupied by the Germans, for instance, having been assigned to them before the late Mr. Handy, the first Commissioner-General, was appointed. The Germans also did better than they otherwise might have done because they furnish for use a large proportion of the power plant at the Champ de Mars, and in connection with it have been able to place some of their tool builders in very prominent places—even better places, I think, than those occupied by the French tool builders, notwithstanding the fact that the Frenchmen reserved for themselves 55 per cent. of all the space in that department, leaving but 45 per cent. for all other nations combined, their conduct in that regard being in very strong contrast to that witnessed at Chicago, where the foreigners had practically all of the best space in Machinery Hall, and made almost no use of it.

When Mr. Peck, the present Commissioner-General, arrived in Paris after his appointment the space had been already apportioned to the various nations. That assigned to the United States machinery exhibitors was seen to be totally inadequate, and Mr. Drake conceived the idea of building an American machinery annex at Vincennes. He had difficulty in getting anything like adequate space even there where there appears to be all out-doors for room. As the work progressed Commissioner Peck asked him to provide for exhibitors of machinery in other lines than machine tools; exhibitors who could not get space at all at Champs de Mars, and whose exhibits at Vincennes, it was thought, would augment the general interest of the exhibition there, and thus be a help to all. This was done by building additions (necessarily of wood) to the originally planned steel building. Among the exhibitors thus taken in were Frazer & Chalmers, of Chicago, who at the last moment, on account of the South African war, drew out; paying finally as a forfeit $500, which was about 10 per cent. of the expense that had been gone into to accommodate them. At the time Mr. Drake was here in Paris, and, as someone had to be obtained to occupy the vacated space quickly, he was perforce obliged to find exhibitors whose representatives were here and could give immediate and definite answers. He is now devoting a portion of his time to efforts to raise money to meet a deficiency existing in the receipts as compared with the cost of the building, and which he says he must beg or steal, and as he can't steal he must beg. My impression is that American machinery exhibitors who take the trouble to look into the matter will conclude that they are much indebted to Mr. Drake, and that they would have fared much worse had it not been for his untiring efforts and thoroughly intelligent grasp of the situation.

It is Mr. Drake's expectation now to open and dedicate the machinery building at Vincennes on May 10, one object of this being to call special attention to the machinery exhibit then in a way that will probably not be possible when, ten days later, the entire Vincennes annex is opened with a fete, which President Loubet will attend.

A NEW PRATT & WHITNEY LATHE.

The Pratt & Whitney Company have been so long building lathes, and have built so many good lathes, that very naturally any new thing undertaken by them in that line can be expected to attract special attention, irrespective of its intrinsic novelty; and new features are not lacking in their new 14-inch lathe, Fig. 2,* shown at the Vincennes annex. In general appearance the lathe is as unlike its predecessors as it is reasonably possible for a lathe to be, the new machine being an advanced example of that new school of machine tool design which eschews every square inch of finished surface that is not essential to construction or operation. The castings have the boldly rounded corners and simplicity of form characteristic of this style, the gears are as much as possible covered, and not only does the lathe look exceedingly well to one who has studied and accustomed himself to this modern style, but there can be no doubt that with average care, such as lathes ordinarily receive in use, it will look much better to everyone at the end of, say, five or ten years' service than does the lathe that has originally more finished surface.

The bed is of the box form, a web extending throughout its length near the top, and a similar one at the bottom. The front shear for the head and footstocks and the rear shear for the carriage are flat, thus leaving only one shear in each case to do the lateral guiding of carriage and footstock—a feature the merits of which Prof. Sweet has been preaching for many years. There is in this case a compound rest, particularly to meet the views of European users, and the now well-nigh universal improved form of footstock, which leaves room for working the slide parallel to the lathe shears.

It has been thought best by the builders to carry the motion from the lathe spindle to the lead screw as directly as possible and using as few gears as possible. For this reason the screw cutting train is plain and direct, without "frills." But for feeding there is a gear box attached to the feed rod which, by means of a lever, gives three different rates of feed for each step of the feed cones. There are two of these steps; they are for a relatively wide feed belt, and the great ratio between the steps is filled in, so to speak, by the three rates obtained by moving the lever. There is also a clutch on the feed rod, which is automatically disengaged by setting a collar upon the rod.

The face plates are centered upon the spindle by a ground cylindrical seat at the front, and are drawn back against a collar (forming part of the spindle) by a thread cut upon the outside of this collar. The carriage apron is double, affording a bearing at each end for all studs used there. This lathe has in the shop easily reduced a cast-iron piece 3½ inches in diameter to 2¾ inches diameter with a feed of 14 per inch. It weighs more than the 16-inch lathe of the older style by the same makers, who exhibit other interesting machines that will be taken up later, as opportunity offers.

[This lathe was described and illustrated by us last week. It will be seen that Mr. Miller works in a number of additional particulars of interest concerning it.]

SOME HERBERT TOOLS.

An exhibit which, although not at all well located at Champ de Mars, is nevertheless likely to attract attention is that of Alfred Herbert, Ltd., of Coventry, England. We have previously shown some of Herbert's tools in our columns, and our readers know that they are constructed on American lines, and yet are not American tools, nor blind copies of them, but include features thought by the builders to better adapt them to the British market.

Fig. 2 is what they call their "Capstan lathe with patent chasing saddle." Most of the features of the machine will be readily understood from an inspection of the photograph. It is intended for chucked work rather than for that which is made from the bar, and for chasing threads on brass or other pieces the carriage is moved by a short lead screw, seen in front, and this is engaged by a leader made of brass or bronze and double-ended, as usual with Fox lathes. This is attached to a small cross slide at the right of the carriage apron, which slide is moved toward or from the lead screw by means of the lever handle seen below, which handle also moves the chasing tool in or out from the work simultaneously. By moving the upper one of the two handles seen below the headstock four different speeds are obtained for each lead screw, and the screws are exchanged to get further range. The turret slide is fed automatically, and in front of the slide is a hexagonal bar rotated in unison with the turret, to each of its six sides being attached an adjustable releasing tappet and stop for the feed. The lower one of the two handles reverses the motion of the lead screw.

Fig. 3 is a larger machine, also for chucked work mainly, and the designer, having recognized the importance of proper cutting speeds, has provided for obtaining them with little trouble. There are two sets of back gears, one being in the ratio of 4 to 1, the other 15.8 to 1, and either of these can be thrown in or out while the machine is running by means of the two vertical levers seen at the usual location, which operate frictional clutches. There are two speeds for the countershaft, and thus there are six speeds available without changing the cone belt, and including this change the very well arranged schedule of speeds that follow are obtained: 4.5, 6, 7, 8.5, 10, 14, 17, 23, 27, 32, 37, 51, 72, 100, 115, 138, 160 and 221 turns.

This machine has a similarly arranged chasing arrangement for the carriage and a turret tool post on the cross slide for holding four tools. The flange for holding the chuck is forged solid on the spindle to reduce the overhang as much as possible. There are eighteen rates of feed for the turret, six of which are available by the movement of a lever without shifting the feed belt, and the feeds are divided into two series; one fine, for drilling or boring in solid metal, the other coarser for boring cored holes and turning, the change from one to the other being made by moving a lever.

AUTOMATIC SCREW MACHINE BY HERBERT.

A large and a small automatic screw machine are shown by this firm, and the photograph Fig. 4 is of the larger one as set up for making six-pounder shells for quick firing guns, the machine being employed, or, rather, it being the intention to employ it, in the exposition for making the supporting studs or pillars for locomotive hand rails. As is readily seen, the machine embodies the main features of the Hartford automatic, but is not an exact copy, an especial point of distinction being in the frame, which is of cored section and much more massive in appearance. The drive for the large machine is not direct on to the spindle, but to a shaft at the back running at a higher speed and driving the spindle by means of a pinion and gear wheel. Thus narrow and high-speed belts are used, which can be shifted quickly, and the arrangement is such that both the belts can be open and one of them faster than the other, where it is desirable to alter the speed of the work during its progress, as for tapping or threading, and, of course, this change of speed is made automatically, the same as though it were reversing. For finishing the second ends of studs, etc., this machine is provided with a magazine attachment, which consists of an inclined trough of a width suitable for the length of the studs, and so adjusted that the lowest stud is in line with the center of the spindle at the rear. A rod fastened to the bar-feed slide pushes this lower one forward into the chuck, and when withdrawn allows another stud to fall into place, the ones above, of course, following, and the machine thus handles short pieces automatically, each new piece as it is shoved into place pushing its predecessor out.

A NEW CHUCK.

A chuck shown on one of these machines is constructed as shown in the longitudinal section, Fig. 5. It opens and closes by power, but the chief point claimed for it is that it will grip a bar of stock that may vary 1-32 inch above or below the nominal size. This feature is more important in Great Britain than in America, because it is not so easy to procure there stock that is uniform in size.

*The illustration called for by this figure number is the same as Fig. 1 of the article "A New 14-inch Lathe," of last week's issue. It will be seen that Mr. Miller gives a number of additional particulars of interest.

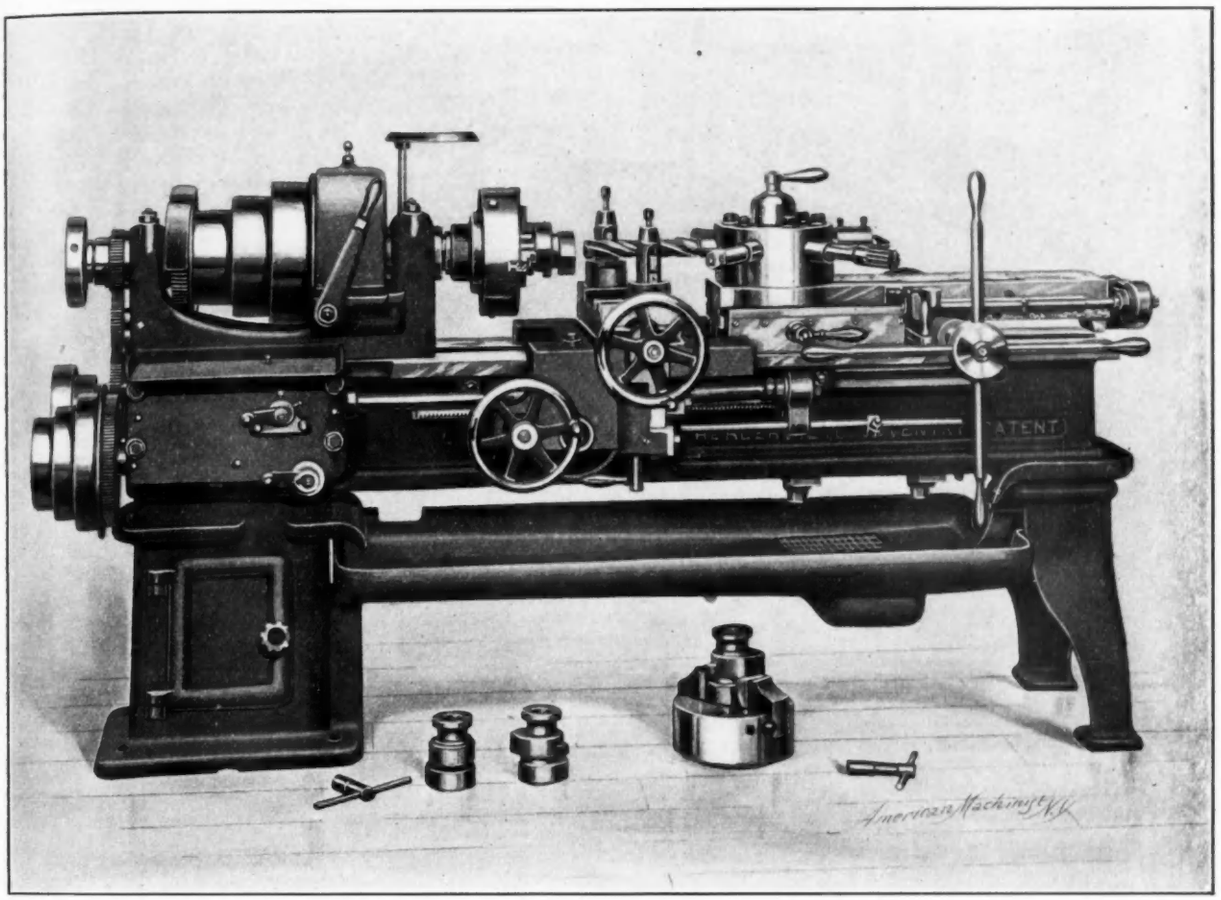


FIG. 3. ALFRED HERBERT'S CAPSTAN LATHE WITH CHASING SADDLE.

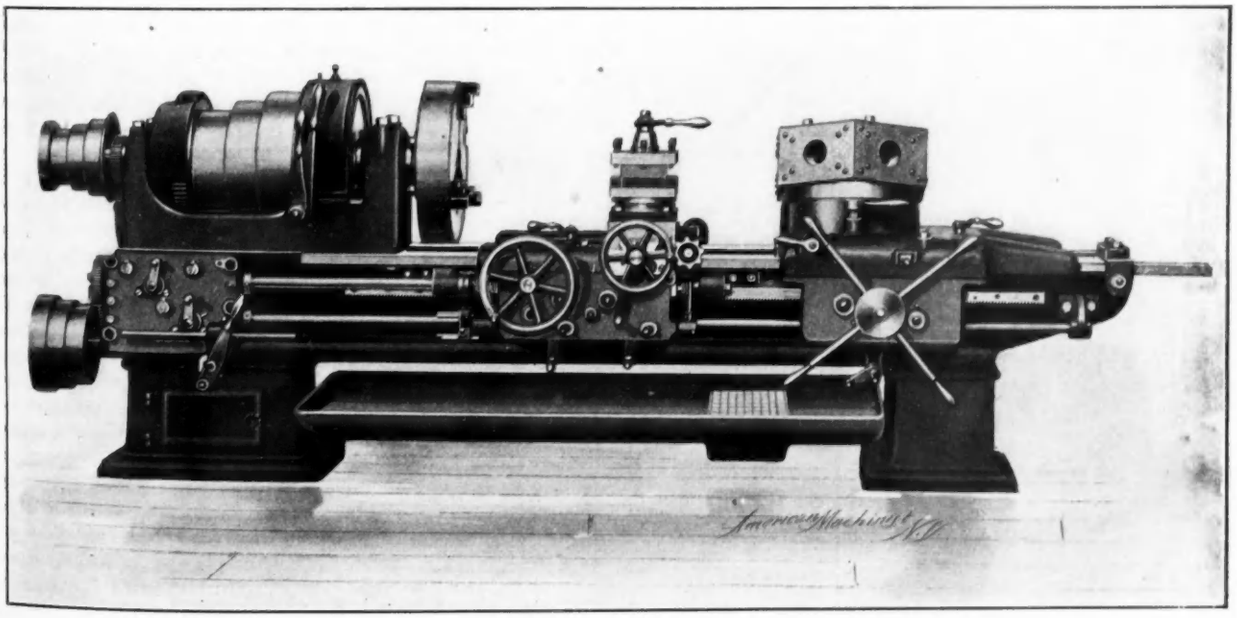


FIG. 4. HERBERT'S INCLINED HEXAGON TURRET LATHE WITH CHASING CARRIAGE.

I "fancy" that an American using stock in an automatic screw machine would rather vigorously object to paying for extra stock above the size wanted, and then paying for the cost of removing it from the bar as well. But, however that may be, the fact remains that this chuck is interesting as a mechanical structure. Referring to the section, *A* is the end of the spindle, and to this is screwed the chuck body *B*. This is of steel and is tapered at the outer end to receive the three pieces *C* composing the collet. The piece *B* is threaded externally, and at its rear end is enlarged to form the spur gear *G*. The steel cap *E* engages with the pieces *C* at the front in the manner shown, and is moved forward and back upon the spindle to open or close the chuck, the forward and backward motion being effected by means of the sleeve *D*,

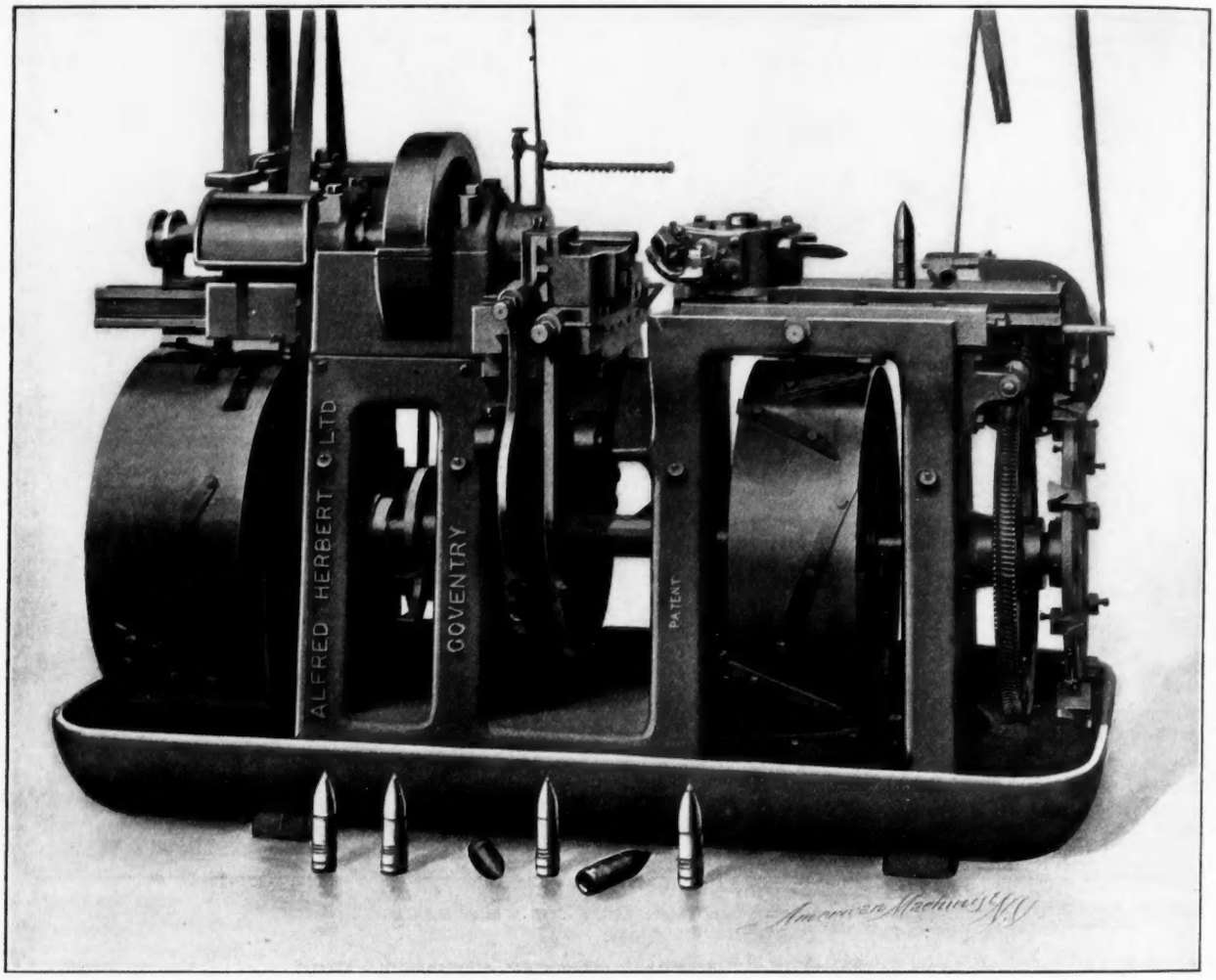


FIG. 5. LARGE AUTOMATIC SCREW MACHINE BY ALFRED HERBERT.

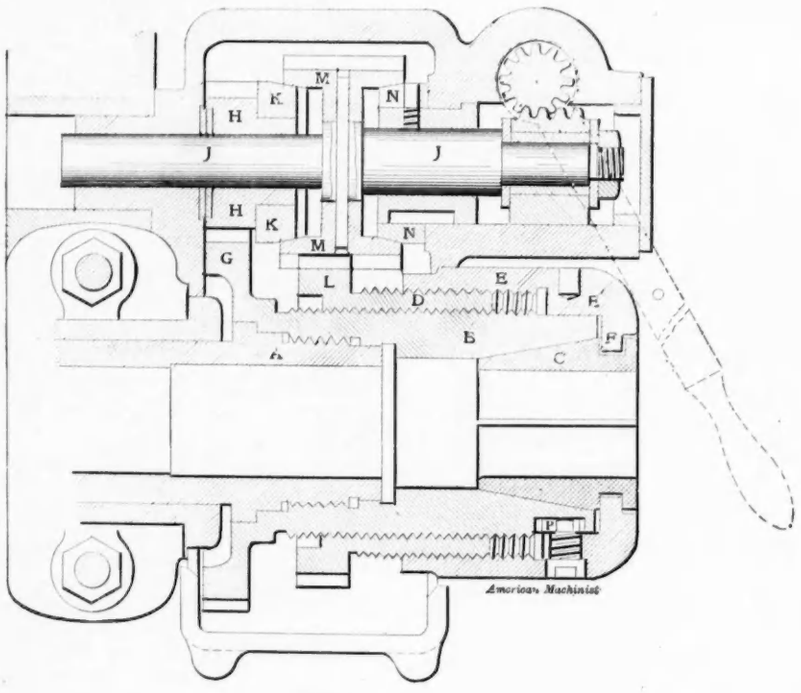


Fig. 6

POWER-OPERATED CHUCK FOR SCREW MACHINES—ALFRED HERBERT.

which is threaded internally to engage with *B*, and externally to engage with *E*, both these threads being right-hand, but differing slightly in pitch. *B*, *E* and *F* always revolve with the spindle, but the sleeve *D* may be either held still or revolved faster than the spindle, and thus by its differential threads produce the required longitudinal movement of *E* and *G*. This is effected by means of the double-friction clutch *K M N*, the cone *K* being loose on the shaft and driven at a speed higher than the spindle by the gear *G*, while the cone *N* is fast to the casing and does not revolve. The clutch is completely encased, to form an oil bath, and the pieces *C* are removed or inserted by simply running sleeve *E* out to its fullest extent. When the jaws are closed upon the bar with sufficient pressure, the friction clutch *K* slips, this pressure being, of course, regulatable by the hand lever which throws the clutch, and which is located above the spindle. If you are going to accept and use stock that varies widely in size, this chuck will save much hard jerking of levers and adjustment of gripping devices.

F. J. M.

Paris, May 4.

The Strength of Gear Teeth.

BY ROBERT A. BRUCE.

By far the most rational and convenient method of treating the question of the strength of gear teeth is that developed by Mr. Wilfred Lewis in his paper, entitled "Investigation of the Strength of Gear Teeth," read before the Engineers' Club of Philadelphia on October 15, 1892. At the end of his paper Mr. Lewis gives an equation for determining the strength of bevel wheels, and a convenient approximation sufficiently accurate for most purposes is added. No demonstration, however, of the result there arrived at is given, and it is therefore hoped that the investigation of the question which follows may be of interest to those who use the formula without precisely following the process by which it has been derived. Those who are familiar with the paper referred to will have no difficulty in perceiving that the following alternative equation may be derived directly from that given by Mr. Lewis, and is, in fact, the same equation expressed in different terms. The graphic treatment of the question is added with a view of saving numerical work and bringing bevel wheels under the same rules as those used for finding the strength of spur wheels. The strength of spur wheels may be calculated directly by means of Mr. Lewis' constants and equations, which are well known, or by using the Cox gear computer. The diagram for gear strengths has been constructed in order that the working load on gears may be obtained without numerical work or the necessity of consulting a table of constants. Results within 1 per cent. of those that would be obtained by using the Lewis formula and constants may be insured by means of a simple measurement applied to the intersection of two selected lines, and conversely, the dimensions of a gear may readily be found to fulfil given conditions.

In considering the strength of bevel wheels a very slight examination of an actual case is sufficient to show that the simple formula for spur wheels needs modification, not only on account of the tapering section of the teeth, but also because the tooth profile is itself considerably modified by the shape of the tooth, being no longer solely dependent upon the number of teeth in the gear, but being also influenced by the angle of the pitch cone. Both of these points are illustrated by Fig. 1, which represents a half-section through a mitre wheel of twenty-two teeth. In the case of a spur wheel of the same diameter and number of teeth, the tooth profiles, if determined by the Willis odontograph, would be as drawn in Fig. 1. In the case of the bevel wheel, however, the teeth are drawn on the development of a cone whose slant side is *B C*, the effect being that the tooth is strengthened considerably, owing to the fact that in laying out the tooth profiles *B C* is used as the pitch circle radius instead of *B D*. The tooth profile is, in fact, that of a wheel having the same pitch, but the number of whose teeth is increased in the ratio of *B C* to *B D*. It is, moreover, obvious that as regards strength, the bevel wheel may be supposed to possess a greater "effective" number of teeth, in a measure depending upon the angle of the pitch cone. In the case considered, since the angle *B C A* is equal to the half angle of pitch cone, viz., *A E C*, it can be seen that the number of effective teeth can be found by multiplying the actual number of teeth by the natural secant of the half angle of pitch cone. It is well known that it is on account of this property that it is possible to construct bevel pinions with considerably fewer teeth than a spur pinion without unduly undercutting the flanks.

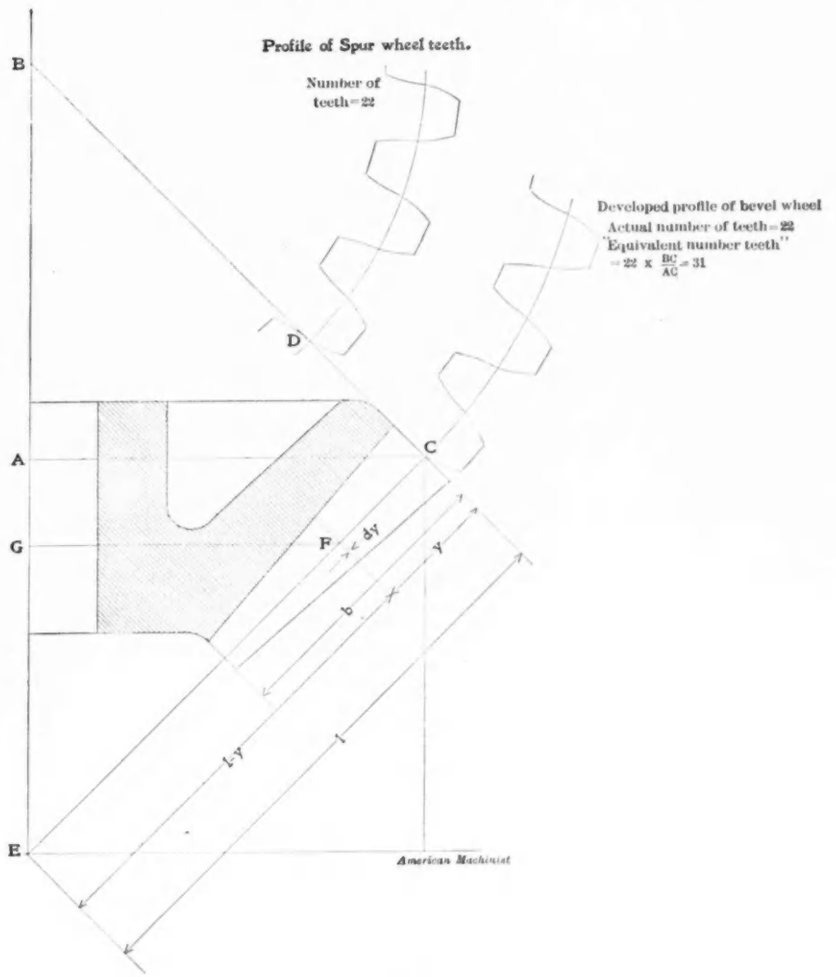


Fig. 1

SHOWING INCREASED STRENGTH OF BEVEL TEETH AS COMPARED WITH SPUR TEETH OF SAME NUMBER AND PITCH.

The exact amount by which the tapering section of tooth reduces the safe load which it can carry can be determined if the ratio of *b*, the breadth of face, to *l*, the length of the slant side of the pitch cone, is known. As in the case of spur gearing, it is convenient to be able to estimate the working load at the pitch line in terms of the pitch, breadth of face and number of teeth. Accordingly, the investigation which follows aims at establishing a rule which can be applied to a bevel wheel in precisely the same way that the Lewis rule applies to spur wheels.

Consider a very small strip of the tooth at *F*, in Fig. 1; let its width be *dy*, and suppose that it is *y* inches from *C*, the point of intersection of the slant side of the pitch cone and the pitch diameter. The pitch at *C* being called p, the pitch at *F* will bear to p the same proportion that *E F* bears to *E C*; that is to say, that the pitch at *F* is $\left(\frac{l-y}{l}\right) p$, and the safe working load carried by this strip will therefore be $k \left(\frac{l-y}{l}\right) p\, dy$, where k depends upon the tooth profile and velocity. From what has been said it will be evident that k is simply the Lewis variable for the "equivalent" number of teeth of the bevel wheels multiplied by the safe stress on the material. In other words, the variable used is that which would be employed in making calculations as to the strength of a spur-wheel tooth, the number of teeth in the wheel bearing to the number of teeth

in the bevel wheel, the proportion of $B\ C$ to $A\ C$. Hence, if n, the actual number of teeth, be multiplied by the natural secant of the half angle of pitch cone, the resulting number may be treated as the "equivalent number of teeth," and the value of k is the product of the Lewis variable for this number and the strength coefficient suitable for the velocity at the pitch line. The safe load carried by this elementary strip of tooth may be reduced to an equivalent load at the pitch line by multiplying by $\frac{G\ F}{A\ C}$, or since $\frac{G\ F}{A\ C}$ is equal to $\frac{l-y}{l}$, the element of load at the pitch line carried by the elementary strip of tooth at F become $\frac{(l-y)^2}{l^2} \times p\ k\ dy$, and by a simple integration the whole safe load at the pitch line becomes

$$k\ p\ b\left(1-r+\frac{r^2}{3}\right)$$

where r is the ratio of b to l, which can easily be got from the drawing. The expression for the safe load is now in the same form as that for spur wheels, with the exception that instead of using the simple breadth of face of the bevel wheel a quantity less than it, in a manner depending upon the value of r, and which may be conveniently called the "equivalent breadth" is used. The equivalent breadth is obviously equal to the breadth of face $b \times \left(1-r+\frac{r^2}{3}\right)$. The calculation of the "equivalent breadth" may be avoided by the use of the diagram Fig. 2 in the following manner: Find r by dividing the breadth of face of the bevel wheel in inches by the length of the slant side of the pitch cone in the same units. On the lower scale of the diagram find the value of this ratio, and from the point so found trace vertically till the curved line is intersected. From the point of intersection trace a horizontal line to intersect the diagonal marked with the breadth of face of the bevel wheel in inches, thence follow vertically till the value of the equivalent breadth is read off on the top scale. If the breadth of face of the bevel wheel is greater than the dimensions marked upon the diagonals, divide the breadth by two, and having found the "equivalent breadth," multiply it by the same number. The full lines on Fig. 2 show how the equivalent breadth is found, when $r = .25$ and actual breadth of face $= 5$ inches, the equivalent breadth being 3.85 inches.

In the same way the diagram Fig. 3 may be used to find the equivalent number of teeth in the following manner: Locate on the lower scale the half angle of pitch cone, thence trace vertically till the curve of secants is reached. From the point of intersection so found, trace horizontally till the diagonal figured with number of teeth of the bevel wheel is met, thence trace vertically and read the value of the equivalent number of teeth on the top scale. Thus for a half cone angle of 31½ degrees and 34 teeth, trace vertically till the point B is reached on the curve of secants; thence horizontally till the point C on the diagonal lettered 34 is met; thence vertically till on the top scale 40 is found to be the equivalent number of teeth. By further following from C downwards till the reference curve is reached at D and then horizontally to the scale on the right hand is met, the value of the Lewis variable can be read direct for the most usual odontoid, viz.: cycloid or 15-degree involute.

In using the Lewis formula a good deal of tedious multiplication has to be done, interpolation or the use of a separate formula being necessary in order to determinate the proper stress for intermediate pitch-line velocities. The same remarks also apply to a less extent to the Cox gear computer, ingenious and useful as it is. In order to entirely dispense with calculation, I have constructed the diagram Fig. 4, and have so chosen the scales that all cases met with in everyday practice are included. The scales on the right and left-hand sides

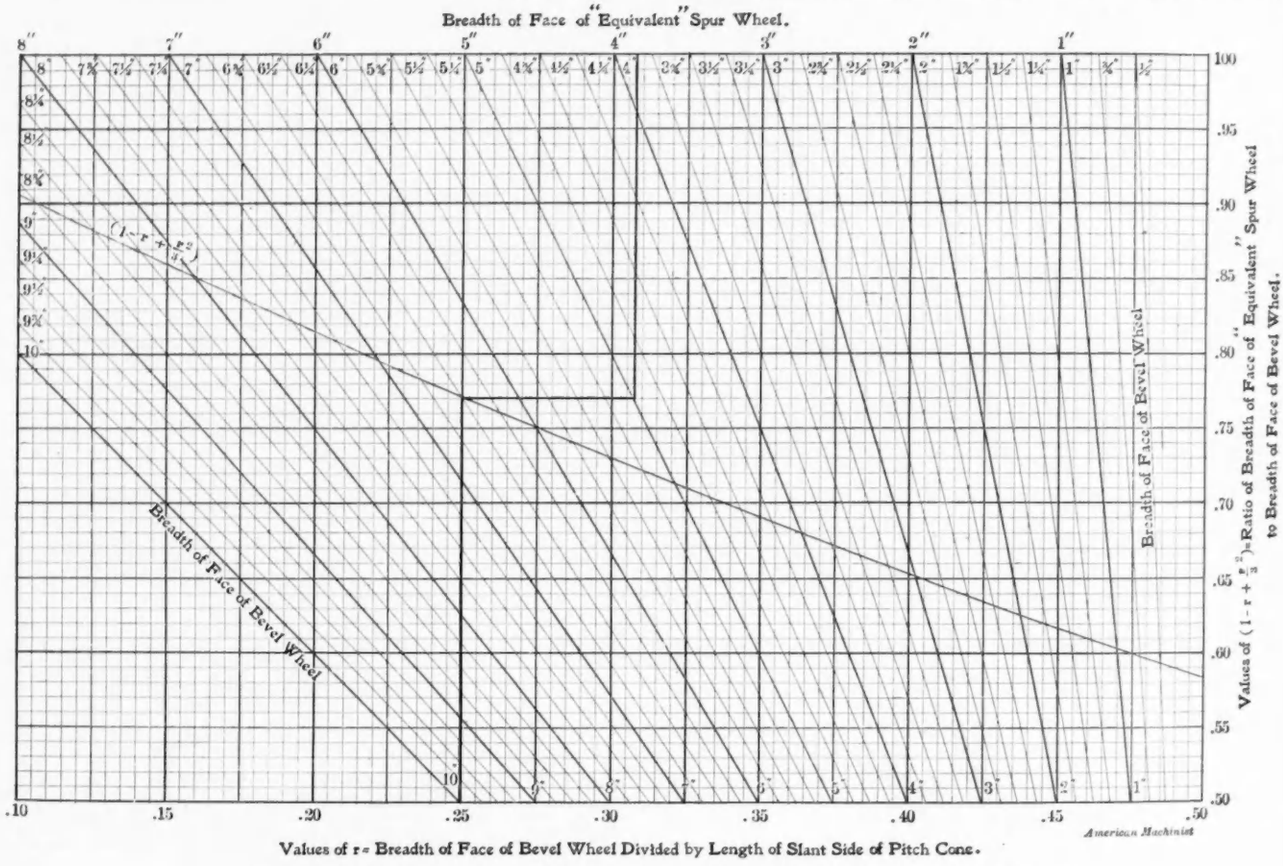

Breadth of Face of "Equivalent" Spur Wheel.
8" 7" 6" 5" 4" 3" 2" 1"
Breadth of Face of Bevel Wheel
Breadth of Face of Bevel Wheel
Values of (1 - r + r²/3) = Ratio of Breadth of Face of "Equivalent" Spur Wheel to Breadth of Face of Bevel Wheel.
.10 .15 .20 .25 .30 .35 .40 .45 .50
American Machinist
Values of r = Breadth of Face of Bevel Wheel Divided by Length of Slant Side of Pitch Cone.

FIG. 2. DIAGRAM FOR REDUCING FACE OF BEVEL GEAR TO EQUIVALENT FACE ON SPUR GEAR.

Directions: Find r on Lower Scale and Trace Vertically to the Curve, Thence Horizontally to Intersection with Diagonal Giving Face of Bevel Wheel, Thence Vertically to Value of "Equivalent" Face of Spur Wheel on Top Scale.

of the diagram are for the diametral circular pitches, respectively. Pitches from 1-10 inch up to 10 inches are given, the subdivision being on the decimal system, on the left hand of the diagram, while the right-hand scale includes all diametral pitches from 30 to 1. Having located the pitch on one or other of these scales, trace horizontally till the diagonal lettered with the required breadth of face is intersected. From the point of intersection so found trace a line vertically upwards or downwards till the top or bottom scale is reached. The former of these is for steel and the latter for cast-iron gears. The point on the top or bottom scale so found requires to be corrected before the safe load can be read, and for this purpose the three reduction scales have been introduced. The choice of which of these is used depends upon the system of generating the tooth profile adopted. Each reduction scale has a scale marked "Number of teeth" and another marked "Pitch-line velocity." A point on the former is noted which suits the number of teeth in the gear, and the distance is measured (by using dividers or by transferring to a strip of paper) from the point on the "Number of teeth" scale to the point on the scale of "Pitch-line velocities," which complies with the speed at which it is anticipated that the gear will be run. This distance is transferred to the "Safe load" scale and applied to the point first found (in the manner already described), so that a new point is found which is below or above it and at a distance from it equal to the transferred distance in a horizontal direction. The only point likely to lead to error is that doubt may arise as to whether the transferred distance should be applied so as to raise or lower the value of the safe load. All confusion, however, may be avoided by remembering that the final point is to the right or left of the point on the scale of safe loads first found, according as the selected point on the "Number of teeth" scale is to the right or left of the selected point on the scale of "Pitch-line velocities."

An example will make this clear. What is the safe load on a cast-iron spur wheel of 30 teeth, 2-inch pitch, 5-inch face, pitch-line velocity being 1,000 feet per minute and the teeth of the 15-degree involute type? Find 2-inch pitch on the left-hand scale and trace a horizontal line till the diagonal figured 5 inches is intersected; from the point of intersection trace a vertical line downwards to the bottom scale. The point so found would be just below 10,000 on the "Safe load" scale. Using the right-hand reduction scale, measure the distance from 30 on the scale of "Number of teeth" to 1,000 on the "Pitch-line velocity" scale. Note that the former lies to the left of the latter. Transfer this distance with dividers or a marked strip of paper, so as to find a fresh point on the scale of "Safe loads" at an equal distance to the left of the point first found which lay just to the left of 10,000. The point so found gives the safe load at 3,000 pounds. It will be obvious that, given any four of the necessary data, the fifth can be found from the diagram. Thus, given 20 teeth, 5-inch face, 1,500 feet per second pitch-line velocity, find the pitch to stand a load of 3,000 pounds, the teeth being 20 degrees involute and of cast iron. Measure the distance from 20 on the tooth scale to 1,500 on the velocity scale, using the middle reduction scale, and note that the former is to the left of the latter. Transfer the distance so found so as to find a point equidistant to the right on the bottom scale of safe loads from the point marked 3,000 pounds, thence follow vertically till the 5-inch diagonal is reached, and thence again horizontally till the pitch scale is reached, when the correct pitch will be found to be 2.4 inches.

The diagram may be equally well used for the teeth of bevel wheels in conjunction with Figs. 2 and 3, the "equivalent" breadth and number of teeth being used.

New Brompton, England.

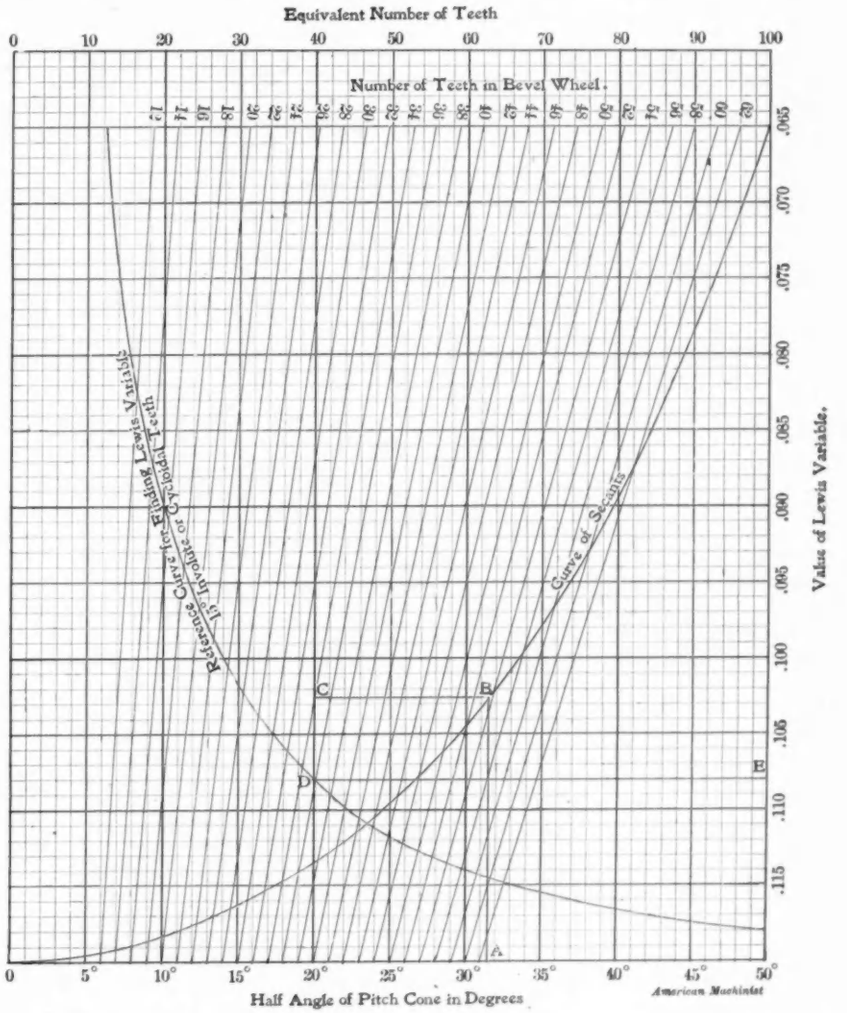

Equivalent Number of Teeth
Number of Teeth in Bevel Wheel.
Reference Lewis Variable
Curve of Secants
Value of Lewis Variable.
Half Angle of Pitch Cone in Degrees
American Machinist

FIG. 3. DIAGRAM FOR REDUCING NUMBER OF TEETH OF BEVEL GEAR TO EQUIVALENT NUMBER OF TEETH OF SPUR GEAR.

Directions: Find Half Angle of Pitch Cone on Lower Scale and Trace Vertically to Curve of Secants, Thence Horizontally to Diagonal for the Given Number of Teeth, Thence Vertically and Read the Equivalent Number of Spur Teeth on Top Scale.

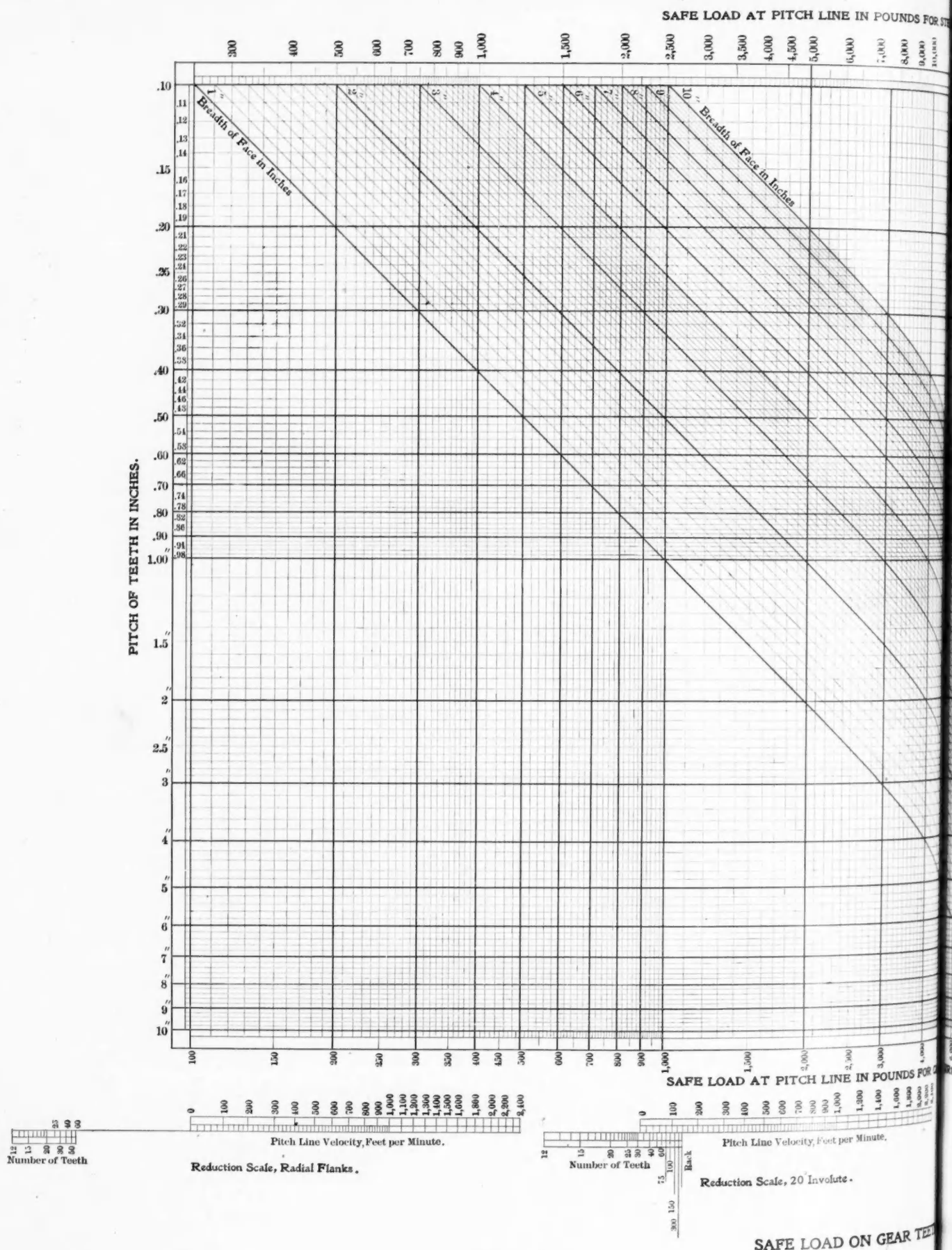
The Rights of the Employer Under the Premium Plan.

A valued New England correspondent asks the following question :

Has the employer a right to any share of the profit resulting solely from the increased efforts of the workman? I see that upon an affirmative answer rests the foundation of the premium plan, and that a negative answer resolves it into piecework pure and simple.

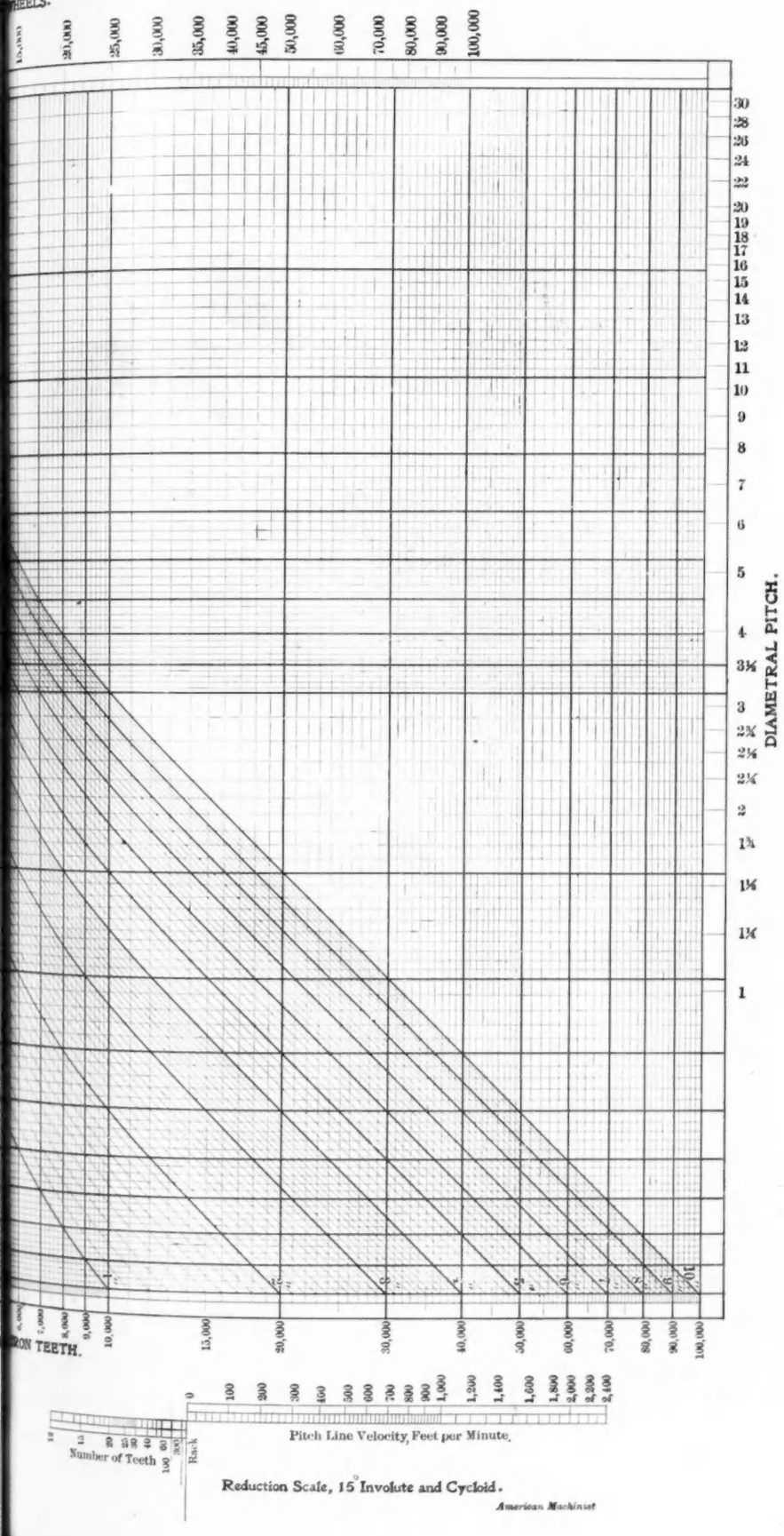
This question has been raised several times by those who endeavor to look into the ethics of the subject, and on this account the answer which was sent to the inquiry is appended:

Replying to your letter, in which you ask if an employer has a right to any share


SAFE LOAD AT PITCH LINE IN POUNDS FOR STEEL WHEEL
PITCH OF TEETH IN INCHES.
1" Breadth of Face in Inches
10" Breadth of Face in Inches
SAFE LOAD AT PITCH LINE IN POUNDS FOR CAST IRON TEETH
Pitch Line Velocity, Feet per Minute.
Number of Teeth
Reduction Scale, Radial Flanks.
Pitch Line Velocity, Feet per Minute.
Number of Teeth
Back
Reduction Scale, 20° Involute.

SAFE LOAD ON GEAR TEETH

Fig. 4



of the profits resulting from increased efforts by the workman, it seems to me that he has such a right. In most lines of production, at any rate in connection with machine shops, this increased production does not call for any large amount of toil and sweat on the part of the workman. It is rather a matter of using his wits and intelligence and attending to the proper speeds, feeds, etc., of which the machinery is capable.

It seems to me that the employer has a right to expect the plant which he provides to be worked to its maximum capacity, and that he is entitled to the profits due to that capacity, provided he pays enough in wages to bring about the maximum output.

From another point of view the question may be looked at as follows: No employer can contemplate paying the same wages cost per piece for his product ten years from now that he does to-day. He must contemplate and expect a steady reduction of these costs. With piece-work this can only be brought about by cuts in the piece prices, the demoralizing effects of which I have endeavored to explain elsewhere. It will thus be seen that while these cuts are, from the workman's standpoint, the embodiment of injustice, they are, from the employer's standpoint, a matter of necessity.

Piece-work *professes* to give the employee all the gains due to his efforts, but *in fact* does not do it, because of these repeated cuts, which cannot be avoided. The premium plan promises less to the workman, but carries out its promises. Under any system it is impossible that the workman should in reality receive all the gains due to increased output, because that means stationary wages cost to the employer.

The chief merit of the premium plan is that a steady reduction in cost is brought about automatically, without any change in the agreement under which the employee works. F. A. H.

Atmospheric Effects on Machinery

Machinery for the mines has been accumulating at the various South African ports for the past few months, and is now lying at all of them in quite considerable quantities. It is likely to suffer a certain amount of damage, for the demand made upon the warehousing accommodation by the military authorities is so great that all ordinary merchandise has to be left lying upon the wharves. The risk of damage is particularly great at Durban, where the hot, damp atmosphere plays sorry tricks with metals. It is, for instance, rather surprising to learn that the life of the rails on the Durban section of the Natal Railway is only one-sixth that of the rails on the uplands sections. The steel work of the bridges, also, is a constant source of trouble, and more men are employed repainting and scraping bridges on the little

North Coast Railway than on all the rest of the section. No kind of special paint will resist this corroding action of the atmosphere—a fact which is much commented upon in South Africa, and offers an excellent opportunity for inventors. The paint remains intact, but the surface of the metal peels off just the same. As opposed to this experience, it is wonderful with what impunity metal can be exposed to the air in the dry, clear climate of the Transvaal.—"Engineer and Iron Trades Advertiser."

The Tabor Vibrating Frame Molding Machine.

We herewith present the latest development of the Tabor molding machine. This is the fourth time that this machine has been illustrated and described in our columns, and each time it has been with full justification, and to the satisfaction and edification of numerous readers. The successive types of this machine which we have shown happily illustrate the progress of successful mechanical invention. The progress in this case has been most distinctly in the direction of simplicity, and at the same time of greater efficiency and wider adaptability.

The contrast is very great between the combination of apparatus comprising the original machine, as shown by us ten years ago, with its steam press built into the foundry floor, its length of track, its cars carrying the molds to be alternately run under, or rather over, the press and then out again, and the present machine, which is entirely self-contained and may be set upon the foundry floor anywhere, which makes available solid and gated patterns already in use without change, uses, if desired, the same matches and flasks which have always been employed, and finishes each mold as it goes along, instead of first ramming a lot of one half of the mold and then, after a change, ramming a lot of the other halves. The machine, besides being simpler than any previous construction, not only costs nothing for patterns, but actually is a saver in pattern cost, as the patterns are not subject to the abuse, mutilation and accidents incident to hand ramming.

The machine itself needs no description. It is simply a press operated by compressed air, the pressure being applied below, the piston being stationary and the cylinder rising, carrying the flask with it; the ramming being done by contact with the balanced ramming head, which swings over it when the ramming is to be done, and back again out of the way when the other manipulations occur.

An essential feature of the apparatus is the vibrator frame to which the patterns are attached. This is shown in Fig. 1, the patterns in this case being two bases for oil stoves, or something of that character. The vibrator frame is used for all styles of patterns. At the lower left-hand corner of the cut is shown the style of pin used for the drag or nowel parts of snap flasks, and at the right is the pin for the cope. The triangular pins seen at each end of the frame fit inside the drag pins, while the cope guides fit outside these pins. Attached to the left handle of the frame is the vibrator, which is similar in action to a pneumatic hammer, a valveless plunger playing back and forth between hardwood anvils thousands of times per minute, setting up a tremor of the frame and of the attached patterns, which frees the patterns in every direction without enlargement of the mold. For attaching the patterns to the frame, the only change in the gating is in the extensions to the sides of the frame. Provision is made for attaching anywhere, according to the style of the pattern. The attachments often may be made from core prints. The openings formed by these attachments may be readily stopped off by pressing in the sand at the outlets with the tips of the fingers after the mold is closed.

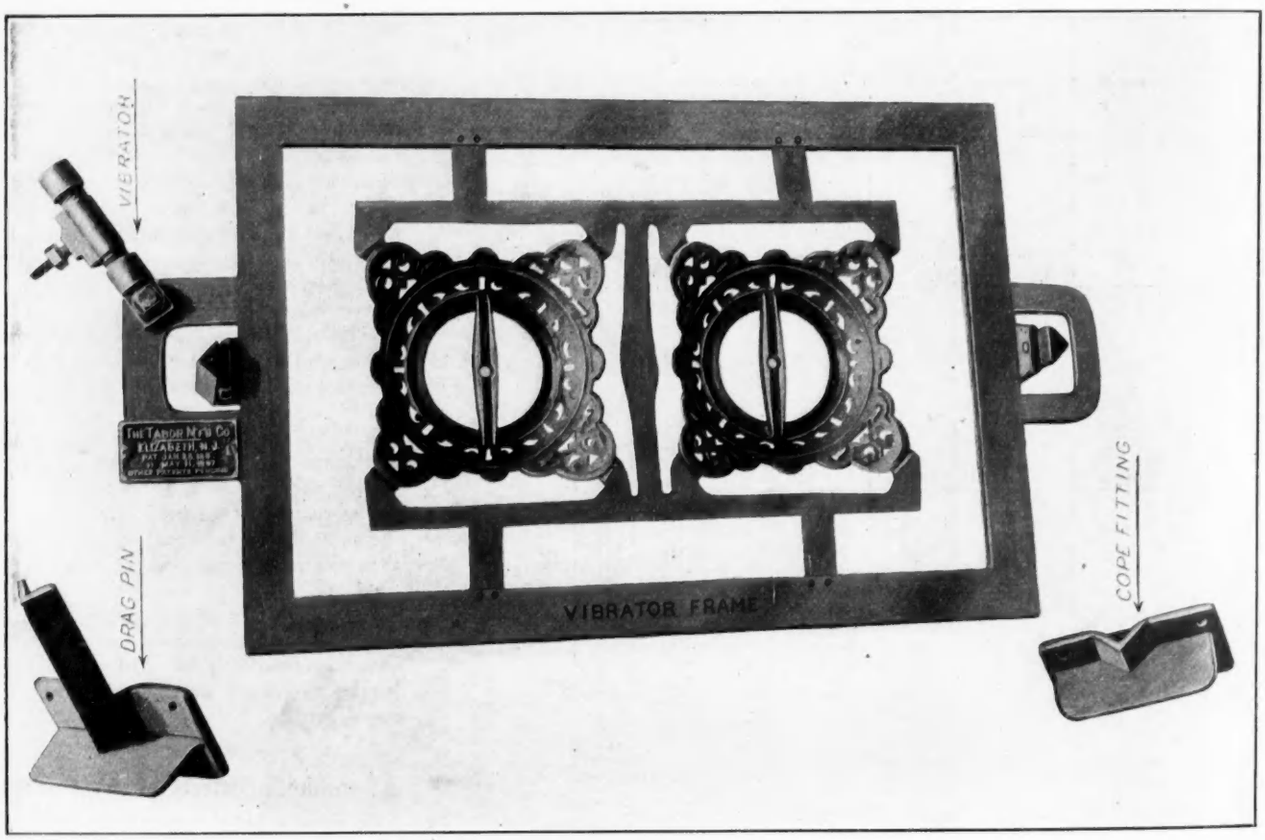


FIG. I. THE VIBRATOR FRAME, VIBRATOR AND PATTERNS.

Figs. 2 and 3 will show the entire series of operations in molding a complete flask. First, the match is laid on the table of the ramming machine and the vibrator frame and patterns are laid on. A small hose of sufficient length connects the vibrator with the air supply. Next, a drag flask is placed in position, its hollow V-shaped pins fitting over the pins of the vibrator frame, as previously described. When the drag has been properly filled

FIG. 2. READY TO RAM THE DRAG.

with sand, the bottom board is laid on, the ramming head is swung forward against stops which locate it vertically, the three-way cock at the right is opened, and the entire rig is forced up against the ramming head. The air is released by another movement of the three-way cock, the table descends to its normal position, and the ramming head is swung back out of the way. The match and drag are rolled over together in the usual way, the match is removed, and the cope is fitted over the pins of the drag. After supplying parting sand and then the molding sand as usual, and placing a ramming board over the cope, the flask is ready for the second ramming, as shown in Fig. 3.

Now, after this ramming come the lifting of the cope and the drawing of the patterns. It is not necessary here to call attention to the difficulty and the uncertainty, or rather the certainty of trouble, all through these operations by the old and too familiar hand methods. Under the present arrangement the operations are simple, easy and certain. Just under the edge of the table of the ramming machine, at the left, is a hinged pad within reach of the operator's left knee. When he is ready to lift the cope, he presses the pad, which admits the air to the vibrator and puts it in operation, and while it operates he lifts the cope, the rapping and the lifting thus occurring simultaneously, instead of the one operation preceding the other. By the use of the vibrator it is made possible to cope many patterns which would be impossible by hand. In drawing the patterns after the cope is lifted, the molder does not use swab or lifting stick, but simply picks up the vibrator frame, while again vibrating the patterns by the pressure of the knee. The most difficult two-part molding is done with certainty and precision by this apparatus and with the best machine speed. The machine is made by the Tabor Manufacturing Company, Elizabeth, N. J.

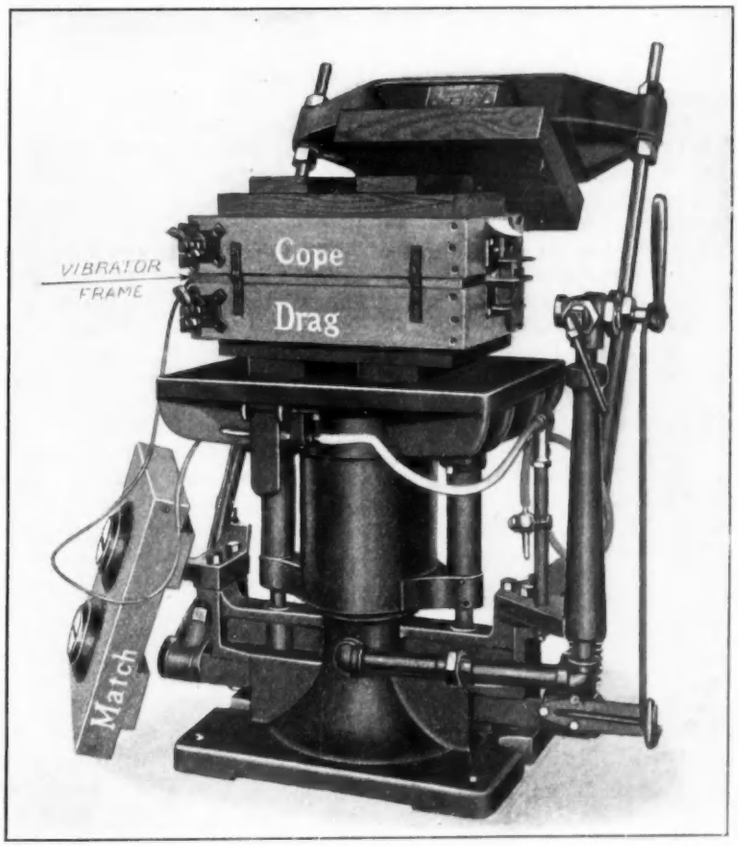


FIG. 3. READY TO RAM THE COPE.

Snakes in Ireland.

The late exposition by Ex-Consul Geo. F. Parker of the happy-go-lucky way in which business interrogatories to consuls are prepared and reports given to the public finds curious illustration in a late report from our Consul-General at Hongkong, on the possibilities of the Chinese market. A particular section bears the distinctive and attractive title, "Crank Shaping Machines for Planing Iron and Steel." One naturally looks under it for some very instructive information about the reasons why just that particular type of machine constitutes a feature of the Chinese market, and what are the peculiar prospects for its success among the Mongols. But behold the communication: "There is practically no market for machines of this class in this market or on this coast," etc.

Construction of the Curve $PV^n = C$.*

BY PROFESSOR D. A. LOW.

The object of this article is to describe a simple method of drawing any number of curves of the form $PV^n = C$, and to show how to find out whether a given curve is of this form, and if so, to find the value of the index n. The construction to be described will also be applicable to finding the value of n in the curve $PV^n = C$, which most nearly agrees with a given curve which may not be exactly of this form.

In the equation $PV^n = C$, P usually denotes the absolute pressure of a given mass of a gas when its volume is V, and n and C are constants. The equation gives the relation between the volume and the pressure of the gas when both are subject to change under certain conditions, without any alteration in the mass of the gas considered.

Fig. 1 shows the graphic representation of the equation $PV^n = C$. OX and OY are two axes at right angles to one another. A length measured from OX parallel to OY represents absolute pressure, and a length measured from OY parallel to OX represents volume, both lengths being measured with arbitrary scales selected before the diagram is drawn. The curve AB is such that if a point A be taken on it, and if P_1 denote the length of the ordinate AE (measured with the pressure scale), and if V_1 denote the abscissa OE or AF (measured with the volume scale), then $P_1V_1^n = C$. In like manner for any other point B, $P_2V_2^n = C$, where $P_2 = BH$, and $V_2 = BK$.

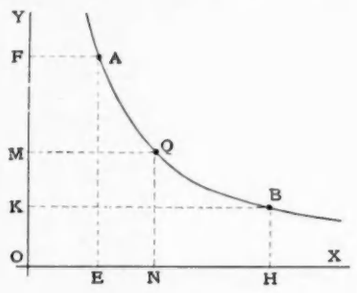


Fig. 1

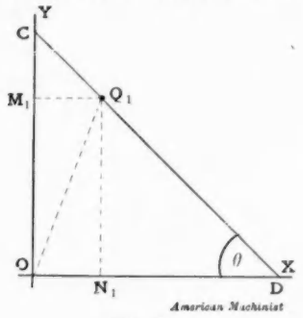


Fig. 2

DEMONSTRATION OF THE METHOD.

Taking logs. of both sides of the equation $PV^n = C$, we get, log. $P + n$ log. V = log. C, or $y + nx = k$, where y = log. P, x = log. V, and k = log. C.

Now $y + nx = k$ is the equation to a straight line. Referring to Fig. 2, OX and OY are two axes at right angles to one another, and CD is a straight line cutting these axes at D and C. If any point Q_1 be taken in CD, and perpendiculars Q_1M_1 and Q_1N_1 be drawn to OY and OX respectively, then

$$\frac{OC}{OD} = \frac{CM_1}{Q_1M_1} = \frac{OC - OM_1}{Q_1M_1} = \frac{OC - Q_1N_1}{Q_1M_1}$$

therefore $Q_1N_1 + \frac{OC}{OD} \cdot Q_1M_1 = OC$

or $y + nx = k$,

where $y = Q_1N_1$, $x = Q_1M_1$, n = the constant $\frac{OC}{OD}$, and k = constant OC.

If lengths parallel to OX are measured with the scale which measures the lengths parallel to OY, then n, which is equal to $\frac{OC}{OD}$, is also equal to tan. Θ.

It follows from the preceding notes that if a curve AB (Fig. 1) be given whose equation is $PV^n = C$, and if a point Q in AB be taken, and if a point Q_1 (Fig. 2) be found such that Q_1M_1 = log. QM and Q_1N_1 = log. QN, then all points such as Q_1 determined in this way will lie on a straight line CD, and OC will be equal to log. C, and $\frac{OC}{OD}$ will be the value of n.

There is nothing new in what has just been explained, but the application of the foregoing principles in the manner now to be described may be new; at all events, the writer has not seen it published anywhere.

The continual reference to a table of logarithms is avoided by using a chart (Fig. 3), which is constructed as follows: YOY_1 and X_1OX are two axes at right angles to one another, dividing the paper into four fields. Volumes are measured along OX and pressures along OY with selected scales, and the curve $PV^n = C$ comes into the field YOX (called the PV field) as in Fig. 1. The logs. of the pressures are measured along OX_1 and the logs. of the volumes along OY_1 with scales selected for the purpose.

The curve in the field YOX_1 (called the P log. P field) is plotted from a table of logs., any point R on it satisfying the conditions $RN = P$ and RM = log. P. The curve in the field XOY_1 (called the V log. V field) is also plotted from a table of logs., any point S in it satisfying the conditions $SM = V$ and SN = log. V.

The lines corresponding to the line CD in Fig. 2 come into the field X_1OY_1 (called the log. field).

In the chart of which Fig. 3 is a reduction, the scales are as follows: Pressures, ⅝ inch = 20 units of pressure; volumes, ⅝ inch = 5 units of volume; log. pressures and log. volumes, ⅝ inch = 0·2 unit.

We shall now illustrate the use of the chart which has been constructed. First, suppose that a point Q is given on the curve whose equation is $PV^{1.4} = C$ and let it be required to construct the curve. Through Q draw QR parallel to X_1OX to meet the P log. P curve at R, and draw QS parallel to YOY_1 to meet the V log. V curve at S. Through R and S draw parallels to YOY_1 and X_1OX to meet at Q_1. Through Q_1 draw a straight line A_1B_1 parallel to the line joining the point 1·0 on OY_1 to the point 1·4 on OX_1. Any number of points on the curve required may now be determined as follows: From a point q_1 in A_1B_1 draw parallels to YOY_1 and X_1OX to meet the P log. P curve at r and the V log. V curve at s. Through r and s draw parallels to X_1OX and YOY_1 to meet at q, which will be a point on the curve required.

As another example, let the curve CD be given and let it be required to find whether it is of the form $PV^n = C$. Take a number of points on CD and find the points corresponding to them in the log. field. It will be seen that these points in the log. field are not exactly in a straight line, therefore the curve CD is not exactly of the form $PV^n = C$. If a straight line C_1D_1 be drawn among the points in the log. field which correspond to points on CD so that it shall be the straight line which most nearly contains these points, then a straight line through the point 1·0 on OY_1 parallel to C_1D_1 will cut OX_1 at a point whose distance from O on log. P scale will be the value of n in the equation of the form $PV^n = C$, which most nearly represents the curve CD. In this case $n = 1{\cdot}28$.

The saturated steam curve is an interesting example for treatment. The curve EF has been plotted from a table of the properties of saturated steam, ordinates representing pressures and abscissæ representing volumes. If a number of points in EF be taken, and the points corresponding to them in the log. field be obtained, it will be found that they lie on the straight line E_1F_1, from which the value of n is found by measurement to be 1·08, which is rather large. By calculation, $n = 1{\cdot}065$ for saturated steam.

Fig. 3 also shows two curves AK and BH, which have been constructed from the straight lines A_1K_1 and B_1H_1 in the log. field. For these two curves $n = 1$, and therefore A_1K_1 and B_1H_1 are parallel to the line which joins the point 1·0 on OY_1 to the point 1·0 on OX_1.

The P log. P and V log. V curves in Fig. 3 should be constructed with the greatest possible care on good smooth paper, and if squared paper can be obtained sufficiently accurate, this will save time and labor. It may be pointed out that once the chart is drawn any problem to be solved may be worked out on a sheet of good smooth tracing paper placed over the chart.

In determining the value of n the line may be drawn through the point 2·0 on OY_1 instead of through the point 1·0,

* From The Mechanical Engineer.

then the distance from O to where the line cuts $O X_1$ will be twice the value of n. This will lead to greater accuracy.

Engineering students will find the working out of examples such as are shown in Fig. 3 both interesting and instructive, besides giving good practice in accurate drawing and measuring. A particularly good exercise is the determination of the value of n for the adiabatic expansion of steam which has a given dryness fraction at the beginning of the expansion, making use of the fact that on the temperature entropy diagram the adiabatic expansion is represented by a straight line.

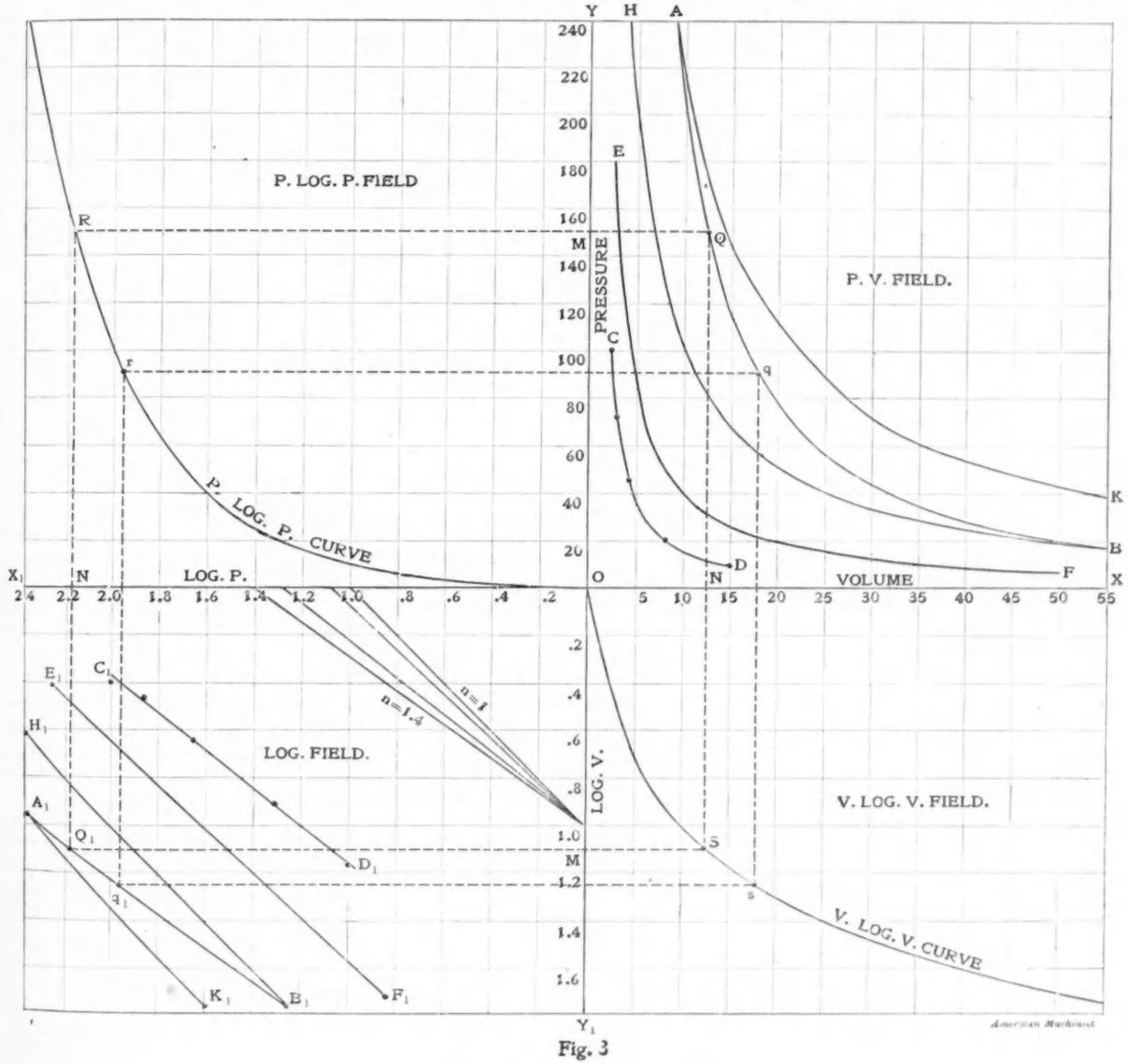


Fig. 3

DIAGRAM FOR LAYING OUT THE CURVE.

Following are the daily average wages of workmen in Belgian nail mills: Nail makers, 94.1 cents; stud makers, $1.102; tack makers, $1.026; wire drawers, 98.8 cents; weighers, 87.6 cents. Ten and one-half hours constitute a day's labor. An increase of about 10 per cent. was recently demanded and a strike threatened.

The Judge's Apprenticeship—Chucks and Chucking—Building Steam Engines.

BY S. A. BETTER.

The 18-inch lathe had a 15-inch scroll chuck weighing, perhaps, 150 pounds. Judge knew it was a scroll chuck, because he had absorbed the information contained in Seth's box of catalogs and circulars when he was sweeping the office. The chuck had three jaws, also three studs connecting the front plate to the back plate. It had about four holes in the edge of the scroll plate for inserting a ⅞-inch round lever and turning the scroll until the lever struck one of the studs. Four moves of the lever would give the scroll one turn. Fifteen minutes was about time enough for closing or opening the jaws an inch. Per cent. of power exerted in pressure on the piece chucked, 1. Per cent. friction in jaws and scroll, 99. Judge found by experimental research that the chuck could be relied on to hold a wheel 14 inches in diameter firmly enough for a light cut with the lathe drill in a short 1-inch hole, provided that the piece was irregular enough and the jaws were set in the flat places, so as to keep it from turning around in the chuck. After Judge had dug this great find out of a corner, cleaned it up and bored about 100 truck wheels with it, he was well satisfied to relegate it to its former resting place and accept the A. W.'s opinion that it was less trouble and gave better results to use the four-jaw independent, which held the work firmly.

Kerr Bros. made a great many pulleys, and had a fairly good set of turned flat lathe drills. These were double-ended, with one end 1-16 inch below and the other perhaps .003 inch below the finished size of the bore, which was reamed by hand with a fluted reamer. (Some of the swiftest boring I have ever seen was done in a modern Chicago shop with such

a lathe drill, and the work was made a nice fit to a B. & S. plug gage without reaming.)

One idea which the Judge absorbed in Kerr Bros.' shop, and which was valuable in late years, was the usefulness of the lathe drill as a cheap two-edged cutter for its particular line of boring. He found that a turned flat drill, made with the least possible clearance, could be made to true up a hole cored considerably out of the center if the drill was started truly and held firmly. This can be done by putting a wrench on the drill and pulling on it so as to hold the drill tightly with the drill holder which is held in the tool post. He also learned that when the cutting edges were beveled the drill followed the cored hole if out of the center much more than when the edges were square.

Kerr Bros. had built in early years a 9x18-inch engine for running the shop, and later a second engine from the same patterns, which, after making an exhibit at the county fair, was sold to the box factory. Bowler, the elevator man, wanted a 10x24-inch engine, so the firm built it for him. Seth and Frank got together, and after they decided on the length of the connecting rod Frank made his pattern for a good big box frame, with top and bottom flanges and several pilasters on each side. The top of the casting was planed and polished its whole length. It was nearly twice as long as the planer bed, so one end was planed at a time, while the projecting end was supported by a wheel running on a rail set on horses. Meanwhile Seth and Frank were making full-size pencil drawings on boards for the other parts of the engine. William Fatigue and A. Billfinger coming along, were hired and set to work on the engine. When the connecting rod and straps were forged, George Croaker, an old experienced vise hand, was hired, and spent a month or two fitting, drawfiling and polishing, and reciting endless stories of his experience and skill in the Judge's attentive ear. The principal impressions gained from Croaker's work were that strap end rods were very expensive, and that when the vise hand's work didn't come out square it was always the fault of the machine hand. The first cylinder, cast in green sand, was a failure, because of a broken port core, but a second trial produced a good casting. The shop had two bars for boring cylinders in the 30-inch lathe. One about 5 feet long, for cylinders up to 8x16 inches, and one about 7 feet long, for cylinders up to, perhaps, 12 x24 inches. These cast-iron boring bars were hollow and tapered from a large middle to small ends, with a flange fastened at the center for holding a tool. The work was bolted to the lathe carriage and fed with the carriage feed. Boring this 10x24-inch cylinder with this rig in about 2½ days was considered fairly good work.

The crank disk was too large for the 30-inch lathe, which had to be blocked up high enough to swing it. For finishing the pin hole it was bolted to the carriage and bored with a small bar on the centers. After roughing out, the disk was shrunk on the cast-iron shaft, which had wrought-iron plugs in its ends for receiving the centers. Finishing and polishing this disk in the chattering, blocked-up lathe was a slow job, requiring several days of light cuts, scraping, stoning with a piece of grindstone and polishing with moderately coarse emery. The crosshead guides, planed all over, were set on turned collars and held with loosely fitting bolts. Judge watched Billfinger "lining up" the engine with considerable interest. The cylinder was fastened lightly with bolts ⅛ inch loose in the holes, and a stick was held opposite the center of the cylinder by a nut on one of the back head studs. Another stick was clamped centrally at the crank end of the bed and a line stretched between the two, and the cylinder then set parallel with the line by calipering. Billfinger then set the crosshead guides and valve-stem guides by calipering from the line, and set the pillow block by squaring from the same line. All these parts were held by loose bolts and secured by dowel pins after lining up.

Billfinger made ground joints on the cylinder heads. Judge asked him why he didn't put on lots of emery and grind it quickly. Although Billfinger's explanation was a little hazy, the questioner afterward learned by experience that the lots-of-emery scheme wouldn't work. The flywheel of this engine, about 10 feet in diameter, had a rim about 6x8 inches in section, and, as double curved O. G. arms were beginning to go out of style, these were made with a single curve. The arms and hub were made in cores, and the rim was swept up in the floor in green sand and covered with cores shaped to give it a channeled section. Risers were made on the hub and rim, and the whole well covered with sand and weighted with pigs and other heavy pieces. As soon as the mold had been poured long enough to set, the rim and hub were uncovered, and when it was cleaned this flywheel proved to be a first-rate casting.

Letters from Practical Men

Is Germany, Financially, a Desirable Stamping Ground for the American Engineer?

Editor American Machinist:

To the writer's knowledge many Americans have been induced to transfer their activities to this side of the pond under the impression that living here is less costly than at home. Good salaries are desirable things everywhere, but they are to be especially desired here so that the ubiquitious tax gatherer may be satisfied. Some day we may attain to the blessed state of feeling a glow of patriotic pride in "shelling out" to help grease the wheels of state, but when the wheels happen to belong to the other fellow's band wagon and he has a conductor in a blue uniform, with a spiked helmet and a short sword, to collect fares, even that inducement to cheerfulness falls out. Every person here that earns $225 a year or more has to pay an income tax to the general government, another to the municipality, and still another to the district; then there is also a church tax. In some places the last three items are lumped into one. The general tax is graded so that small incomes are not taxed quite as high in proportion as larger ones. For instance, an income of $225 to $262 is assessed $1.50 yearly; while an income of $4,875 to $5,125 is mulcted to the tune of $150. These are the limits given on the back of the writer's notice to pay. The amounts do not follow any rule consistently, but agree fairly well with

$$\text{tax} = \frac{\text{Income} - 287}{32}.$$

The municipal and district tax varies with the place of residence, and is always fixed as a percentage of the general tax. In Berlin, for instance, it is 100 per cent., so that there an income of $3,125 to $3,375 is assessed $97.50 for general and another $97.50 for town tax, making a total of $195. To this must be added a further sum for church tax. But if one is located in a district populated chiefly by laboring people, the tax rate is apt to be much higher. In one place just outside of Berlin it amounts to 180 per cent. on the general rate, and the writer has been informed that there are communities in which it runs as high as 400 per cent. If one is unfortunate enough to be the recipient of an income from sources other than one's earnings in the country, that too is fair game for the individual in the spiked helmet, though he is gracious enough to be satisfied with a relatively smaller amount.

As concerns the cost of living, that is about the same for bachelors as it is in our larger cities. A very decent room can be had, with breakfast—coffee and a roll—for about $25 per month. Restaurants are plentiful and quite reasonable in their various grades. German boarding houses are, as a rule, to be avoided, as even those of the better class are not over nice in the matter of table linen, etc. Family life, on the other hand, is expensive. All the necessities are much dearer than with us, and only very few of the luxuries are cheaper. There is absolutely no truth in the inducement held out that living is cheaper, though that statement is usually honestly made. The real fact is that a given income goes further here than in the States only because the standard of life here is distinctly lower. Meats cost two to four times as much, comparing cities with cities and country districts with their like, while all other articles of daily consumption are also much higher. Only beer is cheaper, which is not an unalloyed bless-

ing, even when viewed from a platform other than the one the fair Belva occupies. Nor are clothes cheaper. One can get as good material and a decidedly better fit, ready made, at home for less than a tailor wants here, while "store clothes" here are "slops."

Summing up the writer's experience and that of a number of his acquaintances, it amounts to this: A dollar in the States is worth at least a dollar and a half in the Fatherland. HENRY HESS.

Cams for Geometric Boring Tools.

Editor American Machinist:

In the "American Machinist," No. 18, you describe a very ingenious device for boring polygonal holes, and remark that it is entirely novel in its conception. This is not the case, as an arrangement similar, in principle, at least, has been known for some time.

In his lectures to students at the Stevens Institute of Technology, the late Prof. De Volson Wood was accustomed to describe to his classes and explain analytically the working together of two cams such as are used in the device you describe, as is well remembered by the writer and, doubtless, many other of his pupils.

He considered the action of such cams of any number of sides, the inner having one less than the outer, but in their simplest forms only. That is, taking for simplicity, cams of four and three sides, as shown in the accompanying diagram, the outer cam *A B C D* being square, the inner cam was described as being bounded by the three circular arcs *E F*, *F G*, and *G E*, described from *G*, *E* and *F* respectively, and so having sharp angles at *E*, *F* and *G*, these being, in fact, angles of 120 degrees.

Now it is evident that this construction would not give an operative device, as the sharp corners would very quickly wear off, and I admire the ingenuity, simple though the solution be, that has overcome the difficulty by adding a constant amount all round, giving the operative system consisting of *H I K L* and *M N O P S T*.

Here the wear which before came on the sharp corner *E* is spread over the surface *M N*, and so on. But I would note that the action is in no case one of rolling, but is for the surface *M N* one of rolling plus sliding, and for *P S* one of rolling minus sliding.

I would also note that the drill may be made with as many cutting edges as there are corners to the elementary cam, in the case before us three, thus increasing in that proportion its rapidity and capacity for work; and also that the shank of the drill must occupy no space outside of that included by the elementary cam *E F G*.

I agree with you that this device is likely to find an important place in machine shop equipment, and that its product, once appreciated, will be used in very many ways as yet undreamed of. I congratulate the inventor. EDWIN RUST DOUGLAS.

The Liquefaction and Solidification of Hydrogen.

Editor American Machinist:

I have been somewhat surprised in reading in the "American Machinist," No. 18, in regard to the researches in chemistry of Prof. Dewar, that hydrogen gas has only been liquified and solidified during the present year, as there is excellent authority for asserting that it was accomplished as far back as 1877, in proof of which I give the following extract from Cooley's New Chemistry, Copyright edition, 1881, pages 64 and 65: "Hydrogen, by intense cold and enormous pressure, may be reduced to the liquid form.

"This was first done by two experimenters, M. Cailletet and M. Pictet, working independently, but succeeding at the same time, both in December, 1877.

"M.Cailletet brought the gas under a pressure of nearly three hundred atmospheres, and then suddenly released it. By the sudden expansion of a portion of the gas the temperature of the rest was enormously reduced, and the hydrogen took the form of mist.

"M. Pictet subjected the gas to a temperature of —140 C., and a pressure of six hundred and fifty atmospheres. On opening a valve the hydrogen came out in a jet of steel-blue color. But after a little while, on opening the valve a second time, and although *the pressure was still three hundred and fifteen atmospheres, no hydrogen came out.*

"The fact that no gas issued when under such pressure showed that the hydrogen was not only liquefied, but actually reduced to a solid form: it was frozen."

ALBERT B. CUSHING.

Lowell, Mass.

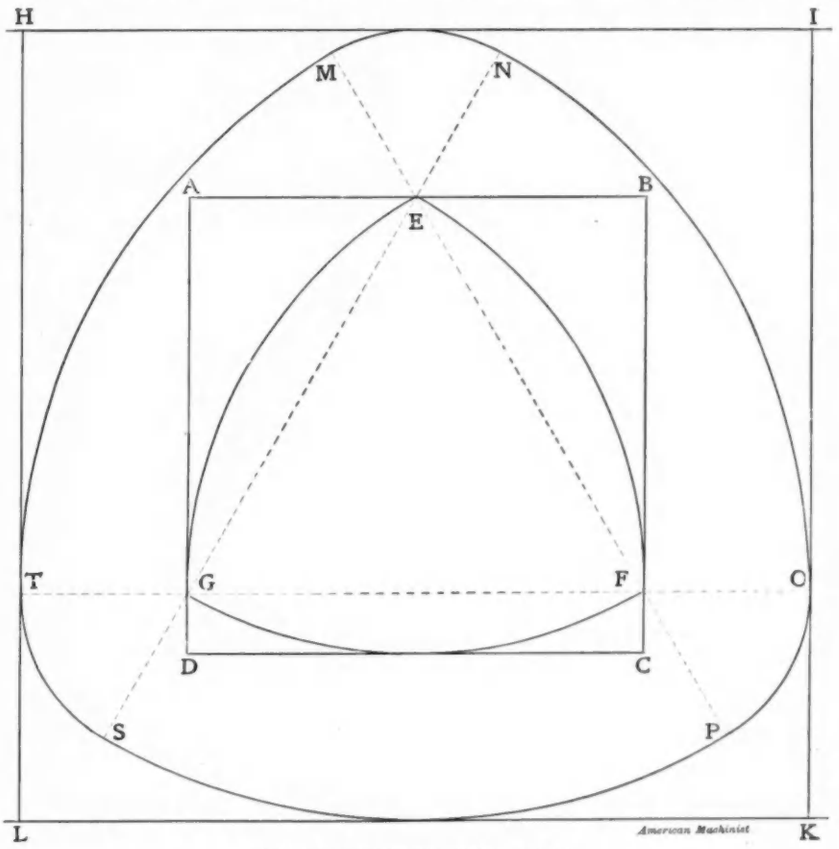
[It will be remembered that the article referred to by our correspondent was reproduced by us from "The Engineer," London.—Ed.]

That Simple Pattern.

Editor American Machinist:

I notice in the "American Machinist," No. 18, a letter from Mr. G. H. Willard, telling us of "very different ways to make a simple pattern." While I agree that his method of molding is preferable to that first mentioned, I am certain that so simple a pattern, 4 inches in diameter by 4½ inches long, glued up from 108 pieces, as shown, would not be considered good practice in any modern shop with which I am familiar; in fact, it would be liable to result in a prolonged "leave of absence" for the pattern maker who produced it.

However, considering only the two fundamental ideas involved, rather than the details, I do not think that either arrangement is the best possible plan. The statement is made that this is a standard piece, and it is therefore probable that many castings will be required, and sometimes at short notice. If I were called upon to devise a method to make this pattern I

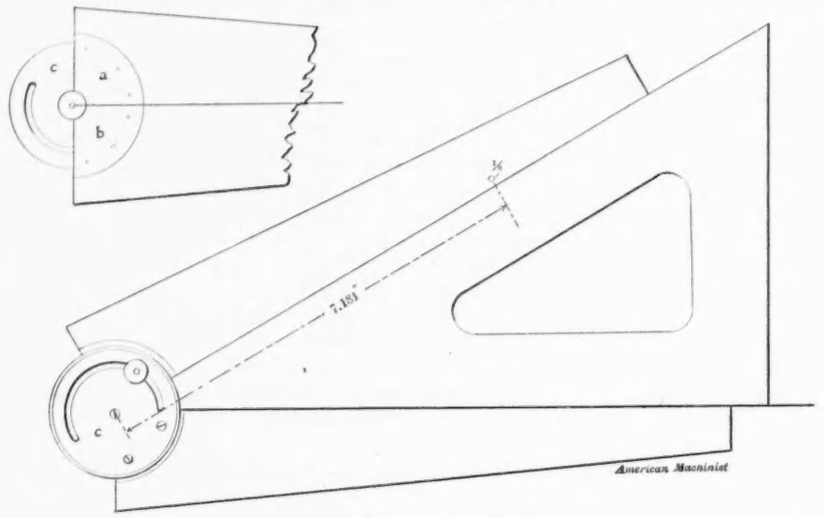


CAMS FOR GEOMETRIC BORING TOOLS.

would part it through its axis, using a straight core. The core prints would be turned solid with the pattern, both halves of the pattern being exactly alike except for the two small dowels in the cope half and the corresponding holes in the drag half. The pattern would thus be made of two pieces of wood, and no special core box would be needed. If it were required to make the pattern specially durable a small rapping plate would be put in each half. With this method we would have a simple and durable pattern, quickly made, the use of stock cores, a straight hole (not tapered), and therefore less stock to be bored out, greater rapidity of molding and just as good a casting in the end.

Of course, there is nothing new or novel in this method. It is the old way, and I believe, all things considered, it is the best shouldered screw through its center into the projection, which screw forms the pivot.

In use in combination with T-square and 45 and 60-degree triangles, the circle may be divided into 5-degree spaces without trouble, and by providing center punch marks ⅛ inch from the inside edge of each arm and 7.184 inches from pivot, each ⅛ inch of chord, minus the constant ¼ inch, equals 1 degree of opening between the arms, and as it is never necessary to obtain more than 15 degrees opening by this means, it is believed this use of a constant increment of length in the chord is admissible, and in fact as near the truth as would be obtained with ordinary care in other ways. The distance 7.184 inches is assumed as a fair average if used to as great an angle as 15 degrees, but if confined to angles of not exceeding 8 degrees, probably 7.174 would be more nearly correct. The chords may be taken with dividers direct from drafting scale, and as 1-32 inch equals ¼ degree of arc, it is possible to approximate ¼ degree easily.



A HANDY ANGLE INSTRUMENT.

However, it is from the simple things that we learn most. Are there any other good ways to do this simple job?

FRED B. COREY.

Handy Angle Instrument for Draftsmen.

Editor American Machinist:

The several letters you have published about various styles of triangles for draftsmen prompt me to offer my design for a handy form that may be called a universal angle. It is somewhat like one that was advertised in your paper a year or so ago, but this was made some time before that advertisement appeared. The sketch shows its construction, as well as its position when set to 20 degrees. The arms are of celluloid, about 1-10 inch thick, and are tapered to the angle of 5 degrees. The joint is of German silver, 1-20 inch thick, made of two quadrantal pieces *a* and *b*, one of which has a circular projection at the corner which fits into a corresponding recess in the other. These are riveted to the celluloid arms and surmounted by the circular plate *c*, having a slot for clamping screw. This plate *c* is screwed fast to *a* and holds *b* by a

CHARLES S. BEACH.

Bennington, Vt.

Night Work.

Editor American Machinist:

At the present time when so many of our manufactories, especially in iron and steel, are pushed to their utmost capacity, some form of relief must be had at times other than by increase of plant. All the help possible being utilized during the day, the manager takes up the idea of running his plant at night. This he may do either by working his day gang longer hours, or by running a separate gang at night. From the point of view of pure economics, there should be no objection to either of these, but rather an advantage, because, presumably, equal amounts of work being produced in equal times, other conditions being the same, we should have while running the plant at night no increase in the general expense attributed to interest, taxes, insurance, etc., and a by no means proportional increase in that of the office and drafting room.

But, as we deal with the actual and not the theoretical man, other factors enter which largely offset this advantage. If the increase in production demanded is comparatively small, the only method to consider is increasing the working hours; the extent to which this may be carried being limited by factory laws, contentment of the help and the quality of the work. High-class help will not work as much overtime as lower, nor young help as long as middle-aged. Fine work cannot be continued as long as rougher, nor heavy as light. In general machine work more than twelve hours overtime, excluding Sundays, per week of sixty hours is likely to cause dissatisfaction after a few weeks. For lower grade work this may be extended to sixteen, or even eighteen, hours overtime per week for a limited period.

If the demanded increase of product be large, the only recourse is to run two or more shifts of men, by which means the plant may be run continuously, though this is rarely advisable. With high-class work were the night work to continue for any length of time three shifts of men would be necessary, nearly doubling the difficulties incident to two shifts, which are by no means small. Machinery, like human beings, is also better off for an occasional rest, so that twenty hours out of the twenty-four ought not often to be exceeded. This, of course, does not apply to foundries, forge shops, rolling mills, etc., where great loss would be entailed by allowing the metal to cool.

Taking as an example a general machine shop running two shifts, we must have, for successful working under the above conditions, first, complete unity of action between the foremen of the two shifts; second, as complete co-operation as possible between the shifts of men, and third, the work of the two shifts must be as separate as possible. Without the first, no matter how good each foreman may be individually, there will be unending trouble. Unity of the foremen may be obtained in either of two ways—by making one foreman, preferably the day man, superior to the other, or by placing over two foremen of equal authority a third, who will keep in close touch with both. The first method is to be preferred, and in either case the day man should be for a short time with the night shift each twenty-four hours, and conversely with the night man, in order that each shall be familiar with the condition of the work before his shift comes on.

To bring about unity among the men, those engaged upon the same piece of work must be as nearly of equal ability and character as possible. Nothing causes discontent quicker than for a neat man to have a slovenly one take up his work in his absence, or for an accurate one to

have one whose work is barely acceptable. As a rule as good workmen cannot be obtained for night work as for day without extra compensation, and even then a decrease in hourly production will occur, on account of the inferiority of artificial light and man's inability to sleep and rest as well during the day as night.

The third point is one that may be carried to a greater or less extent, depending upon the character of the article manufactured. With a small article on which a number of completed operations are to be performed it is a comparatively simple matter to arrange the work so that an operation will be completed at the time of changing shifts, so that each man may be held responsible for a certain portion of the work. Any further operations to be conducted with this particular machine on the pieces should be carried out upon the pieces upon which he has previously worked. With heavy machine work this is, of course, not economically possible. In erecting work it is generally possible for each gang to have its own machines to work upon, though want of floor space sometimes prohibits even this.

Extreme care must be taken that all tool room articles are returned before closing time, and many articles not commonly found in the tool room must be kept there while night work continues; for instance, such tools as wrenches, spanners, special lathe and planer tools, clamps, dogs, etc. If for any reason a man fits up a tool to suit a special job, and the next time his shift comes on he finds that it has been altered, he will next time endeavor to hide it. This will involve much trouble for the other shift. Any such altering of tools without the consent of the foreman, or the hiding of tools, must be prohibited by stringent regulations. In the matter of ordinary lathe and planer tools each man should have his own set, or, with inserted cutter tools, his own cutters. The first cost will be more, but money will be saved in the end. Each man must be held accountable for the condition of the work from the time that he takes it in hand, except for such defects as he reports at that time, and at closing time for each shift a general cleaning up of tools and work must be insisted upon.

Night work at its best rarely pays in machine works, and it is only rendered endurable when the above points are fully carried out, especially that of unity among the foremen, upon which the success of the others so largely depends.

BOSTON.

Obituary.

Henry Barnett, president of the G. & H. Barnett Company, Philadelphia, manufacturers of the Black Diamond files, died May 22, sixty-three years old. Mr. Barnett was born in Nottingham, England, and was brought to this country when a child. He was apprenticed to a file maker when eleven years old. Shortly after finishing his apprenticeship he, with two brothers, removed to Pittsburgh and started the firm of Barnett Brothers. They soon returned to Philadelphia, and have been making files for more than half a century. Mr. Barnett was a volunteer in the civil war.

While so much is being said of the delays and disappointments in connection with the Paris Exposition, it should be proper to put on record that the Ingersoll-Sergeant Drill Company, of New York, had all its air compressors erected and ready to run on the opening day, being the first American exhibitor to operate and the first exhibitor from any country to run its exhibit by steam. The exhibit of this company is in charge of Mr. John J. Swann, late associate editor of "Engineering News."

New Catalogs.

Charles Churchill & Co., Limited, send us a pamphlet containing a brief illustrated description of their stores for the sale of American tools at London, Birmingham, Glasgow and Manchester, with portraits of the members of the firm. Size, 4½x7¼ inches.

The Cataract Tool & Optical Company, Buffalo, N. Y., has published a neat catalog of its precision lathes and attachments, including turret head, filing, milling, chasing, inside and outside grinding attachments, chucks, collets, counters, etc. It is standard size, 6x9 inches.

The Watson-Stillman Company, New York, has issued a new catalog, No. 56, devoted to

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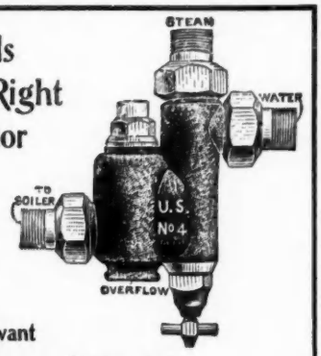

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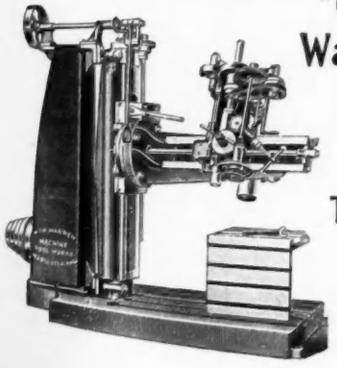

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pumps for hydraulic service. They are shown in many varieties, hand, belt, engine, electric motor and steam driven. Twenty of the sheets comprised are printed for the first time. A telegraph code has been included and all the tools coded. Size, standard, 6x9 inches.

The Bullard Machine Tool Company has gotten out a superb red line and caption catalog of "Modern Machine Tools." It is illustrated with many views of the Bullard shops and of their products—boring and turning mills, combination turret machines, triple-geared lathes, etc., with tools applicable to the machines. We understand that this catalog is prepared with a view especially to circulation at the Paris Exposition. Size, 9x12 inches.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Gear Wheels, gear cutting. Grant; see p. 20.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Forming lathes. Mer.Mach.T.Co.,Meriden,Ct.

Punches & dies. Wal.M.Wks.,Waltham,Mass.

Shaft'g straighteners. J.H.Wells,Tampa,Fla.

Light and fine mach'y to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Book "Dies and Diemaking," $1, post paid. J.L.Lucas,Bridgeport,Ct. Send for index sheet.

Selden Packing for Stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., New York.

Manufacturers of small metal parts and precision machinists, write us; contracts in prospect. Box 273, Bloomington, Ill.

Wanted—One pipe machine to thread pipe and casing from 8 in. down; Eaton & Cole machine preferred. Address "Pipe," AM. M.

Threads and gears; easy rules to cut any thread possible to be cut in the lathe, without algebra, sent to any address for 25c. by G. W. Dixon, Spring Lake, Mich.

New inventions and special machinery of all kinds developed, designed and worked out into practical shape generally, by F. Rochow, 240 Chestnut st., Brooklyn, N. Y.

Wanted, Immediately—Standard gage locomotive, weighing about 20 to 27 tons; state price, condition, location; must be cheap for cash. Room 723, Reaper Block, Chicago, Ill.

Wanted—Horizontal boring machine with about 2½-inch cutter bar; standard make; state with description lowest price; also an automatic gear cutter for cutting internal teeth on wheels 14 in. in diameter. Address "Automobile," care AMERICAN MACHINIST.

Institutions retiring from business having machine tools, brass and wood working machinery will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach. Co., 55-59 Woodbridge st., W., Detroit, Mich.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents.

Situations Wanted.

Wanted—Position as foreman in pattern shop, by an experienced pattern-maker. Address "Pattern Maker," care AM. MACH.

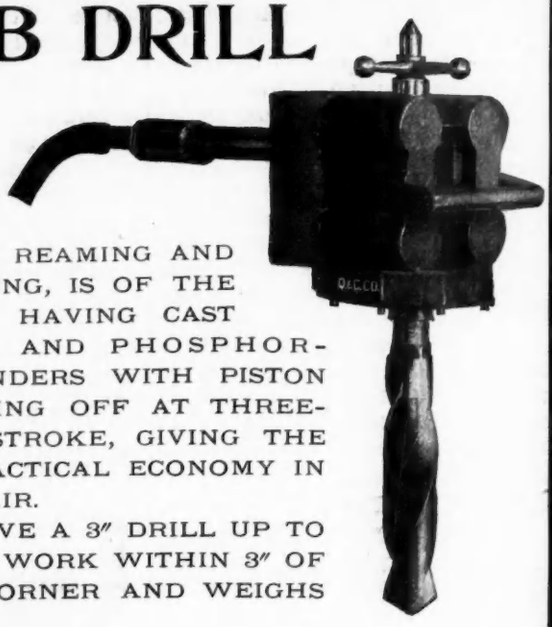
Blacksmith foreman, accustomed to large shop and good business methods; some knowledge of drop-forging; good education; good reasons for change. Box 40, AMER. MACH.

Tool-room foreman and designer of special machinery, with technical education and extensive experience on light machinery, hardware, stamping, etc. Box 52, AMER. MACH.

A mechanical superintendent, good man-

(Continued on page 43.)

OUR B DRILL



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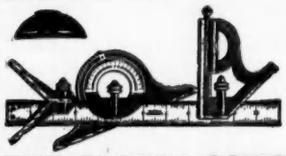

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